INTERAVIA

WORLD REVIEW OF AVIATION AND ASTRONAUTICS

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IN THIS ISSUE

New Weapons for Europe —

with American Participation

VOLUME XIV

No 1/1959

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Volume XIV

INTERAVIA

January 1959

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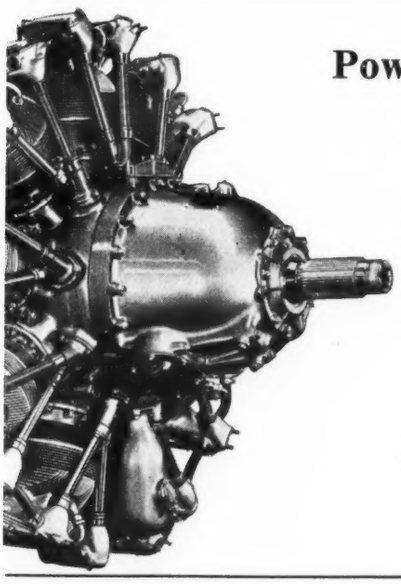
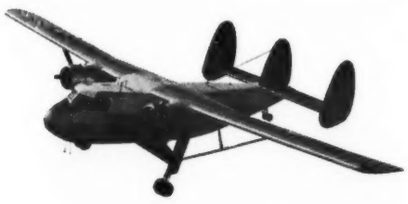
NEW WEAPONS FOR EUROPE
Cooperation . . . with reservations . . . 39
Weapons for Europe—with American Participation . . . * * * 40
The Lockheed F-104 Multi-Purpose Fighter in NATO's Arsenal . . . 43
The Fiat G.91 Strike Fighter . . . 51
Bristol/Ferranti Bloodhound . . . 54
The Multiple Applications of the Nord SS.11 Weapon System . . . 56

The Amphibious Helicopter . . . N. C. TAYLOR, MORTON, PA. 58
A Visit to the Czechoslovak Aircraft Industry . . . E. BAUR, GENEVA 63
The U.S. Airline Industry Strikes . . . 67
Aerojet Produces both Liquid and Solid Propellant Rockets . . . 69
Telecommunications and Electronics . . . 72
Rockets, Missiles and Space Vehicles . . . 74
Afterburner Design and Development in Sweden . . . O. SVANTESSON, STOCKHOLM 76
A Compact Navigational Computer . . . F. M. KIRR, GLENDALE, CALIF. 87
Blind Landings for Passenger Transports ? . . . G. CHAROT, PARIS 89
The 13th Annual General Meeting of the American Rocket Society . . . 90
What's in the Air ? . . . 92
An Investigation of Mid-Air Collisions . . . 95
Deadline Notes . . . 11
Union Syndicale des Industries Aéronautiques . . . 21
New York Finance Notes . . . S. HERSHEY, NEW YORK 22
International Meetings and Conferences . . . 22

FRONT COVER: A Tactical Air Command Lockheed F-104C *Starfighter*, fitted with four auxiliary fuel tanks, being refuelled in mid-air by a Boeing FB-50J.





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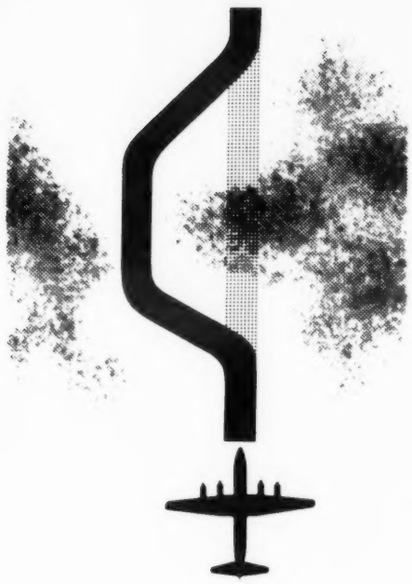

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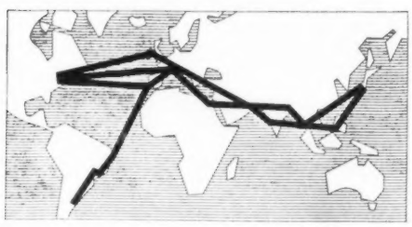

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Offices :

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Correspondents :

Amsterdam : Henk A. JANSEN; *Antwerp :* Roger F. J. GILLYNS; *Athens :* Manos PAVLIDIS; *Bombay :* K. K. ANCHAN; *Johannesburg :* J. K. CHILWELL; *Linköping* (Sweden): Sven WALBERG; *Los Angeles :* Norman LYNN; *Madrid :* Luis SAENZ DE PAZOS; *Melbourne :* Kenneth GREEN; *Mexico City :* José VILLELA, Jr.; *Tokyo :* N. Matsumura; *Toronto :* M. WILLMOT; *Vienna* (and South East Europe): Max W. MORSTADT.

Agents :

Interavia Australasia 5, Tedstone Crescent, Balwyn E. 8, Victoria
Interavia Belgium 5, Heidestraat Noord, Kapellen-Anvers
Interavia Canada 25, Farmcote Rd, Don Mills, Ont.
Interavia France 144, Avenue des Champs-Elysées, Paris 8me
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of world production

13,500 firms
from 51 Nations
are exhibiting
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what to buy

59

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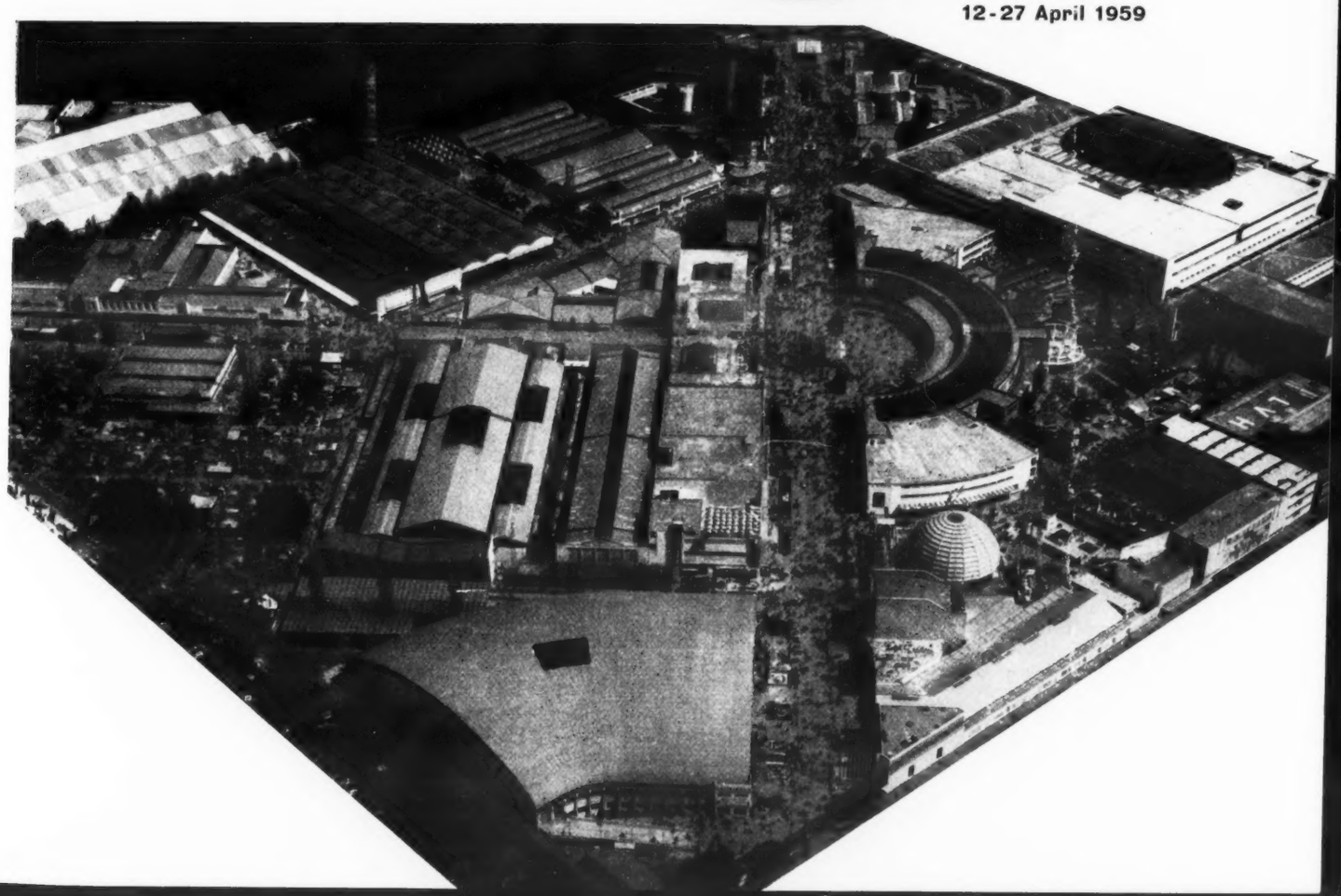
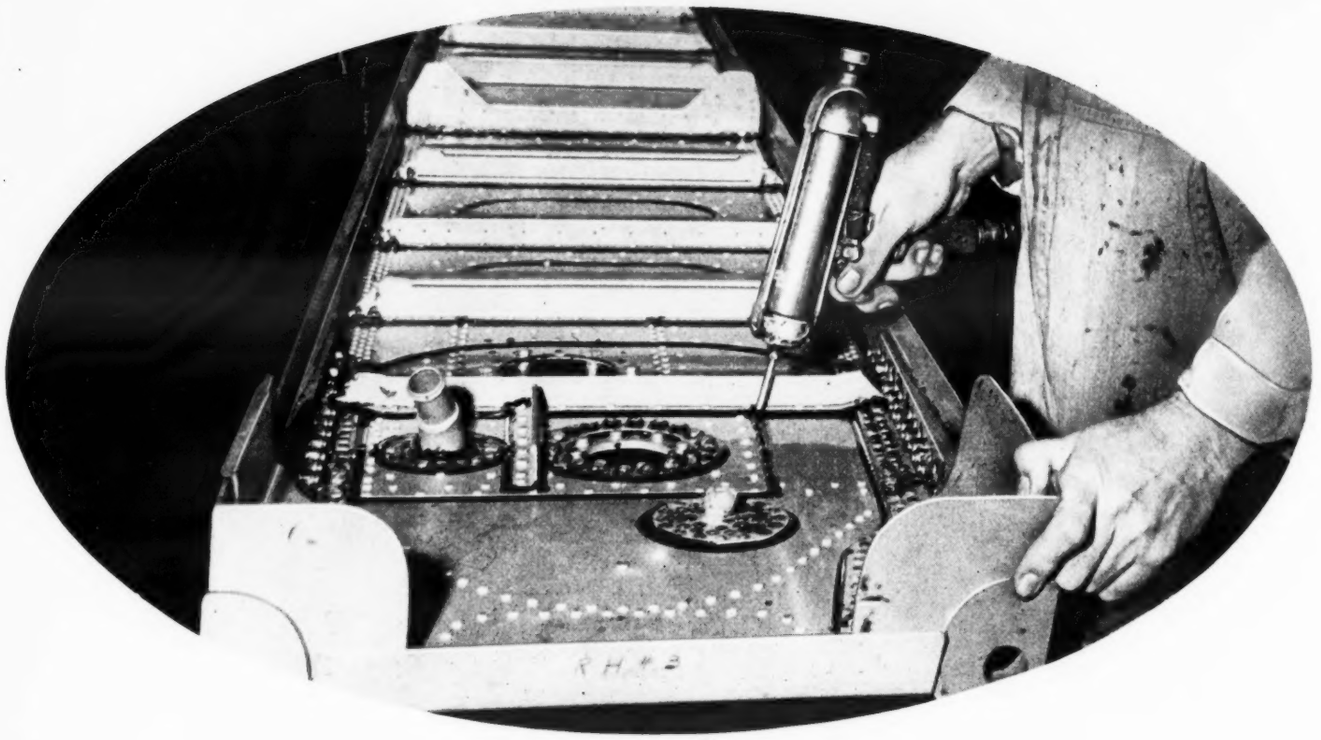
12-27 April 1959





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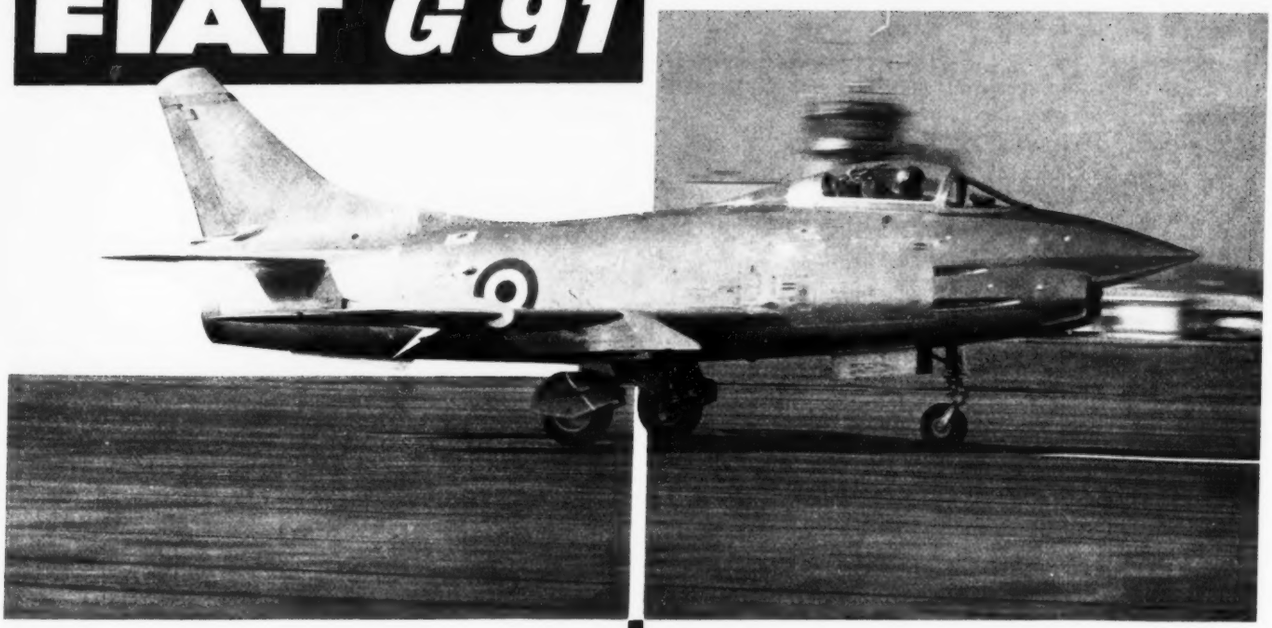

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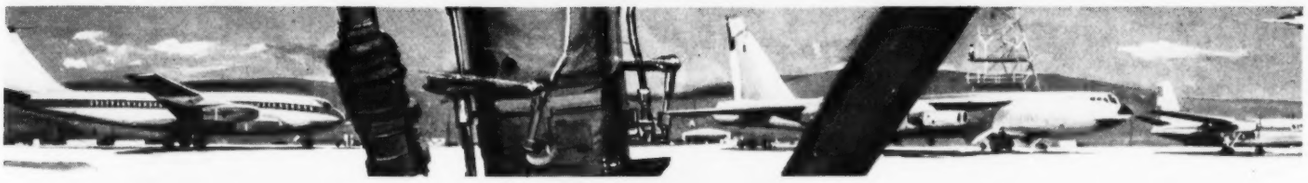

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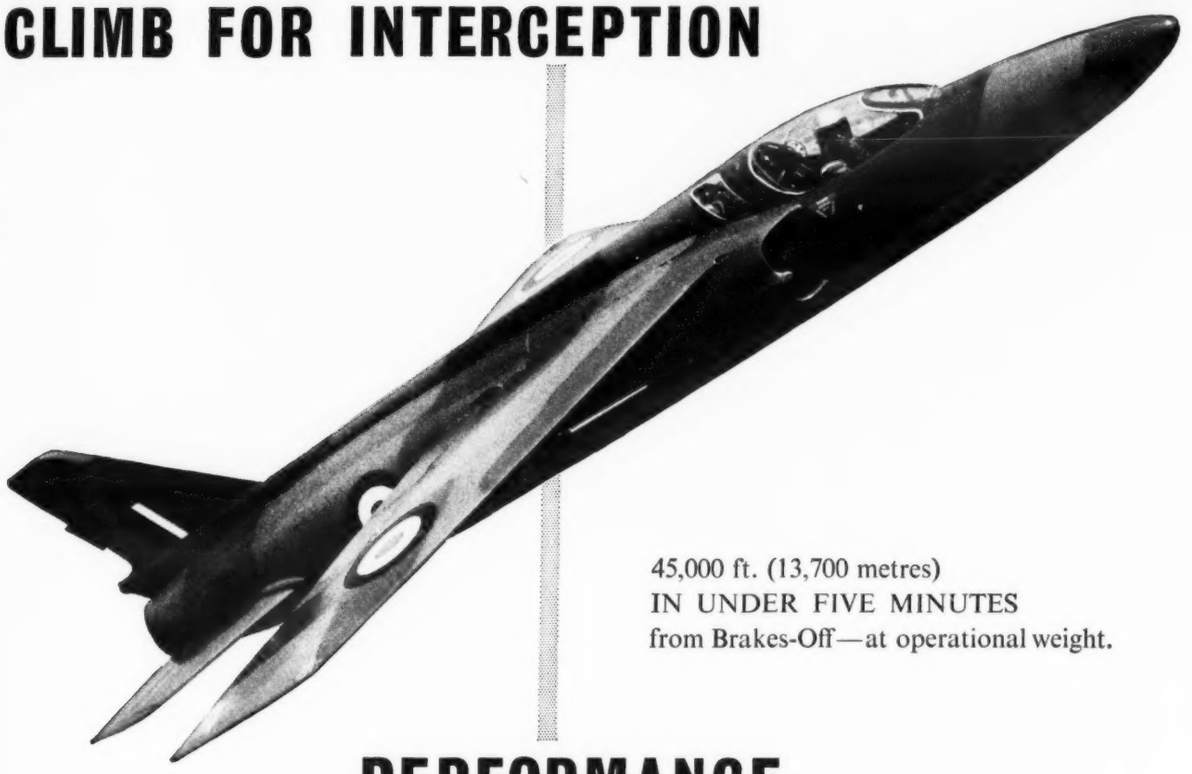

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INTERAVIA

Deadline Notes

No. 1, 1959

• **A coast-to-coast walkout** of 1,500 American Airlines pilots grounded the company's entire fleet of 195 aircraft at one minute to midnight, December 19th, 1958 (cf. elsewhere in this issue). According to *Interavia*'s New York Correspondent, the strike was called despite the settlement which had been reached on one of the major points of dispute—the question of the "third man" in the cockpit of jet airliners. American Airlines and the Air Line Pilots Association have agreed on a "fourth man" formula which will legalize the flight engineers' claim to the third man's seat in jet cockpits, and add a fourth crew member who would be a pilot. A spokesman for the company estimated that the strike would mean a loss of more than $850,000 a day in passenger revenues.

• **The International Civil Aviation Organization** Council at a meeting in Montreal on December 17th, 1958, unanimously elected Ronald Macalister Macdonnell, Deputy Under Secretary of State for External Affairs in the Canadian Government, to be the new Secretary General of ICAO. Macdonnell will take office after the next General Assembly in June 1959, succeeding Carl Ljungberg of Sweden who has been Secretary General of ICAO since 1952.

• **Sabena and KLM Royal Dutch Airlines** have for some time been discussing ways and means of rationalizing European air transport. According to well-informed sources, Lufthansa recently joined in the talks. Sabena and Lufthansa are reportedly anxious to conclude a pooling agreement for North Atlantic services and an accord on the standardization of equipment, but KLM is said to be opposed to such a plan.

• **An extraordinary general meeting** of shareholders, held in Brussels on December 15th, 1958, adopted a proposal to raise Sabena's share capital from 500,000,000 to 750,000,000 Belgian francs. The Belgian Government and the administration of the Belgian Congo have each taken up 62,500,000 francs of the new issue ; the remaining 125,000,000 francs have been subscribed by private shareholders.

• **British Commonwealth airlines in Africa** are to campaign for the introduction of Economy Class fares to Europe at the earliest possible date. An initial campaign meeting was held in Salisbury on December 10th, 1958, between British Overseas Airways Corporation, Central African Airways, South African Airways and East African Airways. In a statement after the meeting, CAA said the conference discussed "questions of scheduling, pool arrangements, operational matters and the joint promotion of further traffic in South, Central and East Africa, with particular reference to the development of inter-territorial tourist and holiday traffic. The conference agreed to continue to press for the introduction of Economy Class fares into Africa at the earliest possible date. It was resolved that these meetings will be held at regular intervals and it is anticipated that a further meeting of a similar nature will be held in Johannesburg during the early part of 1959."

• **Eagle Aviation Ltd.** has applied to the Air Transport Advisory Council for permission to operate air services on eleven British Colonial routes at fares which would be approximately half the present Tourist Class rates and in most instances lower than the existing sea fares. The company proposes to use Douglas DC-6 aircraft with high density layout and the passenger would pay a basic fare—all drinks, food, etc. being purchased as required on the aircraft. The free baggage allowance would be limited to 33 pounds and excess would be charged at the rate of one percent of the one way fare per kilogram. Some of the return fares proposed by Eagle : London-Nicosia, £41 15s 0d (existing Tourist Class £108 0s 0d ; London-Malta, £19 0s 0d (£52 12s 0d) ; London-Singapore, £199 0s 0d (£351 0s 0d) ; London-Trinidad, £165 0s 0d (£283 10s 0d).

Eagle is at present operating scheduled services from London, Manchester and Birmingham to a number of holiday resorts on the European Continent. On these routes, Eagle charges the fares stipulated by the International Air Transport Association.

• **Aeroflot** recently inaugurated regular daily Tu-104 jet passenger flights between Moscow and Vladivostok. The airline will also shortly open a weekly Moscow-Pyongyang Tu-104 service. Travelling time will be 12½ hours.

• **Aer Lingus** has been authorized by the French Government to open two new routes next summer, according to P.H. Brennan, head of the Company's Commercial Department who recently visited Paris. The two new services will be Dublin-Lourdes-Lisbon and Dublin-Paris-Zurich. The Dublin-Lourdes-Rome and Dublin-Lourdes-Barcelona flights will be maintained.

• **Air Algérie** is planning to introduce new services this winter linking Algiers, Oran and Bone-Philippeville with Nice, via Marseilles. An Algiers-Oran service will also be opened. On a number of other routes, frequencies will be stepped up.

• **Ethiopian Airlines** will be admitted as of January 1st, 1959, as an Active Member in the International Air Transport Association, bringing to 87 the number of carriers in the world airlines organization and to eight on the Continent of Africa. Ethiopian Airlines is owned by the Imperial Ethiopian Government, and managed and operated by Trans World Airlines.

At the same time the airline is planning to expand its international operations through the establishment of new routes and the purchase of new turboprop or jet aircraft, some of which are likely to be U.S.-built. The Ethiopian Government is negotiating bilateral route agreements with the governments of Ghana, India, Italy and Lebanon. In addition to service within Ethiopia, the airline now serves Frankfurt, Athens, Cairo, Khartoum, Nairobi, and Hodeida and Taiz in Yemen.

• **A completely new airport** is to be built in the near future on the eastern outskirts of Addis Ababa as part of an expanded international airport programme being undertaken by the Ethiopian Government. The new site is much further away from the mountain range which fringes the present airport on the city's west side, and it will be possible to build runways 12,000 feet long. The new Addis Ababa airport and all the necessary buildings will cost approximately $6,000,000. This is to be financed out of the $24,000,000 line of credit granted by the Export-Import Bank of Washington in January 1957. A portion of the loan was allocated to the purchase of new DC-6B equipment and necessary improvements to Ethiopian Airlines' facilities, with the balance to be used for the improvement of existing airports and the opening of new airports. In addition to the new Addis Ababa airport, major improvements will be carried out on some 33 other civil airports in Ethiopia with the chief work to be done at the airports of such leading cities as Asmara, Dire Dawa and Gondar. The improvements will include better and longer runways, night lights and new buildings.

• **U.S. military budget forecasts :** As the finishing touches are applied to the U.S. military budget for the fiscal year beginning July 1st, 1959, it appears that the Administration will seek to hold defence spending to approximately $41,000 million or slightly more than the $40,800 million estimated in the current fiscal year. According to an *Interavia* report from Washington, the following developments are likely : The Navy will be authorized to request funds for a second nuclear-powered aircraft carrier, but it will have to accept sharp cuts elsewhere in its budget to make room for the carrier ; some sort of cuts in the intercontinental ballistic missile programme appear inevitable. A *Titan* curtailment is very probable, despite U.S. Air Force insistence that the two-stage missile is a second generation missile and not an insurance programme for *Atlas* ; a reduction in the *Thor* and *Jupiter* intermediate range ballistic missiles programme is probable ; the Air Force will probably be ordered to reduce its wing strength still further from the 105-wing level (including both manned aircraft and missiles) authorized for the present year.

• **A number of U.S. missile projects** have recently been cancelled : the Fairchild *Goose*, a long-range decoy missile which would accompany strategic bombers to their targets to confuse the defence ; the Bell GAM-63 *Rascal*, an air-to-ground missile designed to be carried by the Strategic Air Command's B-47 long-range bomber ; the Navy's RAT, a rocket-boosted homing torpedo designed for use by destroyers against enemy submarines.

• **Development of the Nike-Zeus** anti-ICBM missile system will be a substantial item in the defence budget for the next fiscal year. The missile is under development by Douglas Aircraft Company (airframe), Western Electric Company (guidance system) and Grand Central Rocket Company (solid-propellant booster). Expenditures for the project in the current fiscal year are expected to total $250,000,000, with heavier outlays next fiscal year. The ultimate cost of the programme could reach $4,000,000,000 to $6,000,000,000.

• **The National Aeronautics and Space Administration** will order a total of 18 to 20 large rocket systems from the Army Ballistic Missile Agency, and perhaps half that number of large rockets from the Air Force's Ballistic Missile Division, according to the pro-

gramme now under development by the U.S. civilian space agency. NASA now has a firm order for four *Juno II* rockets to be launched in 1959, and it is in the process of ordering another eight *Juno II* vehicles to support its 1959-1960 programme for satellites and space probes. The agency is also negotiating with ABMA for eight or ten *Redstone* vehicles and with the USAF for an undisclosed number of *Atlas* ICBM vehicles for its man-in-space programme. Three *Thor-Able* rockets are on order from the Air Force with additional orders under negotiation.

• **The British Government** has taken a decision to develop a supersonic strike reconnaissance aircraft as a replacement for the RAF's *Canberra*. Announcing this in the House of Commons on December 17th, 1958, the Air Minister said the new aircraft would have "a very high performance at all levels". According to *Interavia*'s London Correspondent, no decision has apparently been made on the manufacturer, but a contract is expected early in 1959.

• **Missiles for Greek forces :** A group of about 200 Royal Hellenic Air Force officers and men have gone to the United States for training in the use of *Nike Ajax* anti-aircraft missiles. The course will last until June 1960. No definite date has been set so far for the delivery of *Honest John* weapons to the Greek Army, although it had been hoped that these weapons would be received by next autumn. Military sources in Athens have indicated that the delivery date depends on the U.S. production rate and training facilities. Meanwhile, the Greek Army Staff has concluded its selection of personnel and has submitted to the U.S. authorities the list of officers and enlisted men who will form the first Greek unit to be trained in the use of *Honest John* missiles. The numerical strength of this first unit will be about fifty, but their training will not take place in the USA as in the case of *Nike Ajax* experts, but in Europe.

• **West Germany's** recent decision to acquire licence production rights for the Lockheed F-104 *Starfighter* is expected to be followed by an early announcement that Japan has also concluded an agreement with Lockheed Aircraft Corporation for the building of the *Starfighter*. The agreement is expected to be on similar terms to that being negotiated with the German Federal Republic, with a small group of F-104s supplied direct from California, and 50 to 75 complete kits to be assembled in Japan while the factory builds up for full production. Projected production plans vary between 150 and 250 F-104 fighters, the precise version of which has not yet been settled.

• **C. Itoh and Company Ltd.** has been appointed exclusive sales representative for Hughes military equipment and distributor of Hughes commercial products in Japon. Among military equipment to come under the sales agreement will be the Hughes-designed armament control systems. Commercial products to be distributed by the Japanese firm will include the Hughes line of germanium and silicon diodes, transistors and other semiconductor devices used in scientific and industrial computers and other advanced electronic equipment. The Japanese company also will represent Hughes direct display cathode ray storage tubes, microwave tubes, and electronic components and instruments, including the memoscope and tonoscope oscilloscopes containing the Hughes memory tubes.

• **Lockheed Aircraft Corporation's** California Division has acquired a 198-acre site near Saugus, Calif., for a new scientific establishment to be known as Lockheed Research Center. The first step in the advanced research building will be the construction of a $5,000,000 supersonic wind tunnel and high-altitude environmental test facilities capable of subjecting complete aircraft to simulated conditions of flight up to 150,000 feet above the earth. A smaller altitude chamber simulating 500,000-foot altitudes—essentially similar to the conditions to be found in outer space—is projected. Construction of the wind tunnel is expected to begin early in 1959. The tunnel and altitude environmental test chamber are planned for completion in mid-1960, when the center will begin operations with an initial work force of approximately 100. Later steps will bring the major portion of Lockheed's California Division research facilities to the new site. Among later steps in the building programme —projected through 1963—will be to supplement the supersonic wind tunnel (up to Mach 5) with one of hypersonic capability (up to Mach 10).

• **Ramo-Wooldridge Laboratories,** a new division of Thompson Ramo-Wooldridge Inc., recently opened $10.5 million premises on a 90-acre site at Canoga Park, Calif. Research will be conducted in electronic counter-measures and reconnaissance systems, infrared systems, analogue and digital computers, air navigation and traffic control, anti-submarine warfare, electronic language translation, information processing systems, nuclear energy applications, missile electronic systems, advanced radio and wire line communications.

• **General Electric Co.** expects to complete a $2,500,000 ram-air test facility early this year at Evendale, Ohio. The installation will be used in the development of GE's J93 turbojet engine which will power the North American B-70 long-range bomber and F-108 long-range interceptor. Both will be Mach 3 aircraft capable of flying at altitudes of 70,000 feet or more. The new ram-air facility will be powered by a 32,000 h.p. electric motor and will also use air from GE's existing compressor in the Flight Propulsion Laboratory. It will include a 1,000,000,000 BTU per hour heater to raise the air flow to temperatures approximating Mach 3 flight conditions.

• **The Sikorsky Aircraft Division** of United Aircraft Corporation has received a $17,000,000 contract for production of HSS-2 twin-turbine anti-submarine helicopters from the Navy. Construction of the first HSS-2 has been started at Sikorsky's Stratford, Conn., plant and the first flight is scheduled for March, 1959. An original contract for the HSS-2, awarded last year, was for design data, mockup and initial production, and totalled $15,000,000.

• **Douglas Aircraft Company's** Santa Monica, Calif., Division has delivered the last of 1,041 DC-6 and DC-7 series aircraft, bringing to an end its production of piston engine transports. The final aircraft, a DC-7C, was accepted by KLM Royal Dutch Airlines which has purchased all Douglas commercial models since the DC-2.

• **Canadair** has received a contract from Boeing Airplane Co. for engineering services in connection with the U.S. *Bomarc* missile programme. Under the contract Canadair will send approximately 150 missile engineers and technicians to Seattle and other points in the United States for a period of twelve months to assist in the engineering of the *Bomarc* weapon system.

• **Lockheed-Azcarate S.A.** is a new commercial aircraft manufacturing company formed by Lockheed Aircraft Corporation and two prominent Mexicans, Abelardo Rodriguez and Juan F. Azcarate. Majority ownership will be held by Rodriguez, a former President of Mexico and Azcarate, an aeronautical pioneer and engineer. The new company's first project will be the manufacture of a light utility aircraft capable of performing a variety of civilian and agricultural missions and designed to fit the topographical and geographical requirements of Mexico and other Latin American countries.

• **Ducellier-Bendix-Air Equipement** is the name of a new company formed by the merger of Société Anonyme des Etablissements Ducellier Air Equipement S.A. and Bendix S.A. The new firm's capital is 3,368,000,000 French francs. Bendix Aviation Corp. had a financial interest in both Ducellier and Air Equipement and the companies were officially listed as Bendix associates.

Workshop Briefs

• **The new Sud-Aviation SE.3200 helicopter,** for 20 to 30 passengers, is expected to commence flight tests in the near future. It is fitted with three Turboméca free turbine engines.

• **Nord-Aviation** recently received a production order for Nord 3202 two-seat (tandem) trainers. The first series of 100 aircraft will go to the ALAT (artillery observation) schools. The Nord 3202 is fitted with a Potez 4D30 motor of 240 h.p.

• **The entire $78,000,000 contract** for production of the Lockheed *Regulus II* guided weapon has been cancelled.

• **A Lockheed F-104 Starfighter** has set up seven new rate of climb records. Climb to 3,000 m in 41.85 seconds, to 6,000 m in 58.41 seconds, to 9,000 m in 1 min 21.14 sec, to 12,000 m in 1 min 39.9 sec, to 15,000 m in 2 min 11.1 sec, to 20,000 m in 3 min 42.99 sec, and to 25,000 m in 4 min 26.03 sec.

• **The Douglas A3D-2Q** radar-jamming aircraft commenced flight testing on December 10th, 1958. An undisclosed number of A3D-2Qs are in production.

• **The U.S. atomic-powered aircraft projects** appear likely to get reduced rather than increased financial support despite the efforts of the backers to secure more funds for development and manufacture. For example, the WS-125A programme will get only "meager" support in the forthcoming Federal budget for the fiscal year beginning on July 1st, 1959.

• **The American Machine and Foundry Company** has been awarded a $29,300,000 contract for the design and development of the *Titan's* launching complex. This project for the USAF Ballistic Missile Division comprises a vertical shaft with multiple side chambers for fuel storage, test equipment and crew quarters. During the pre-launching check-out, the ICBM is housed on a raisable base within the shaft ; immediately before launching the missile is raised to ground level and the baseplate also apparently serves as the launching pad.

• **The first production model of the Convair 880** jet passenger transport, which was rolled out on December 15th, will commence flight testing on January 28th, 1959.

• **The MD.415 prototype** is being assembled at the GAM Dassault Bordeaux-Mérignac plant. The first flight tests on this twin-engine transport and multi-purpose aircraft are scheduled for March 1959. The MD.415, which has a pressure cabin, will be capable of carrying eight passengers and a two-man crew, and has a cruising speed of 340 m.p.h. It is powered by two Turboméca *Bastans*. The aircraft will be suitable for use as a pilots' and navigational trainer, etc. Armament can be provided for the MD.415 in the shape of removable containers or loads suspended beneath the wings.

• **Britain's Air Registration Board** has granted the Rolls-Royce *Conway* (civil version RCo.10) an airworthiness certificate for 17,000 lb. thrust.

• **Two prototypes of the M 222** twin-engine touring aircraft are reportedly nearing completion at the Simmering-Graz-Pauker aircraft division.

• **The Dassault Mirage IV bomber prototype** is scheduled to begin flight testing in mid-February 1959.

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Bristol Siddeley

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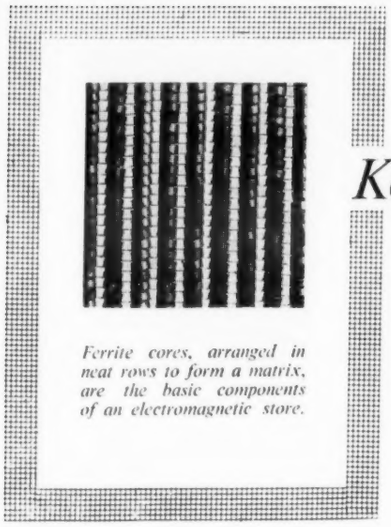

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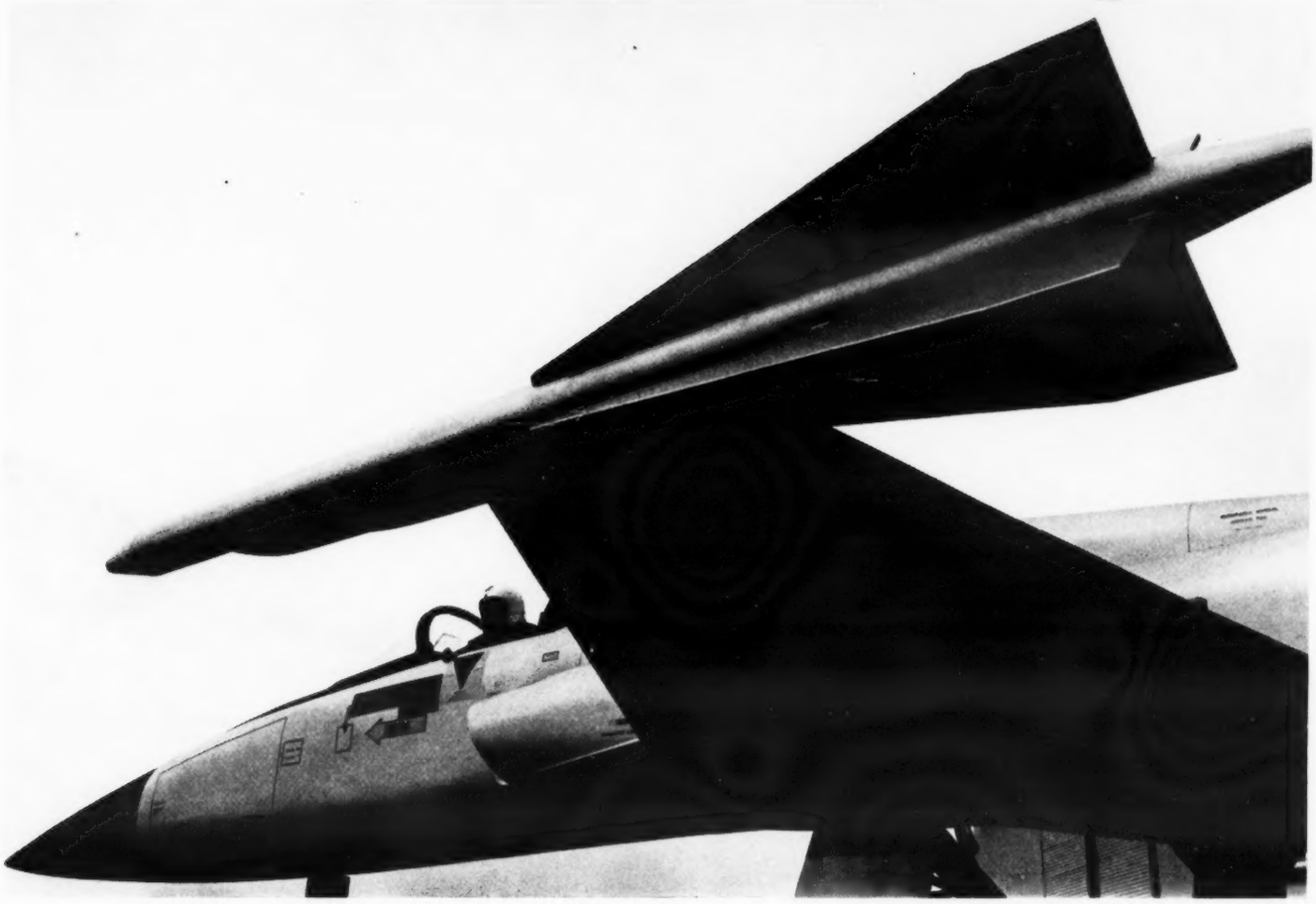

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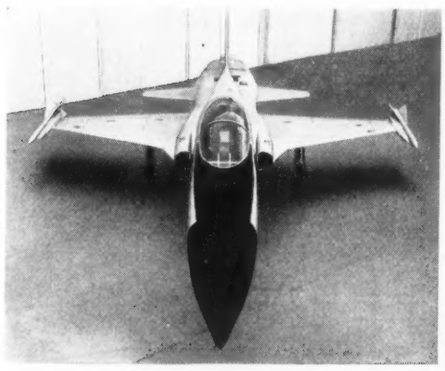
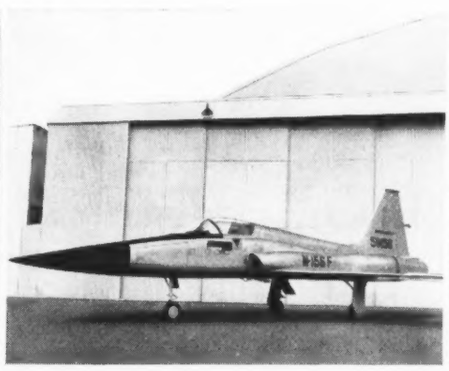
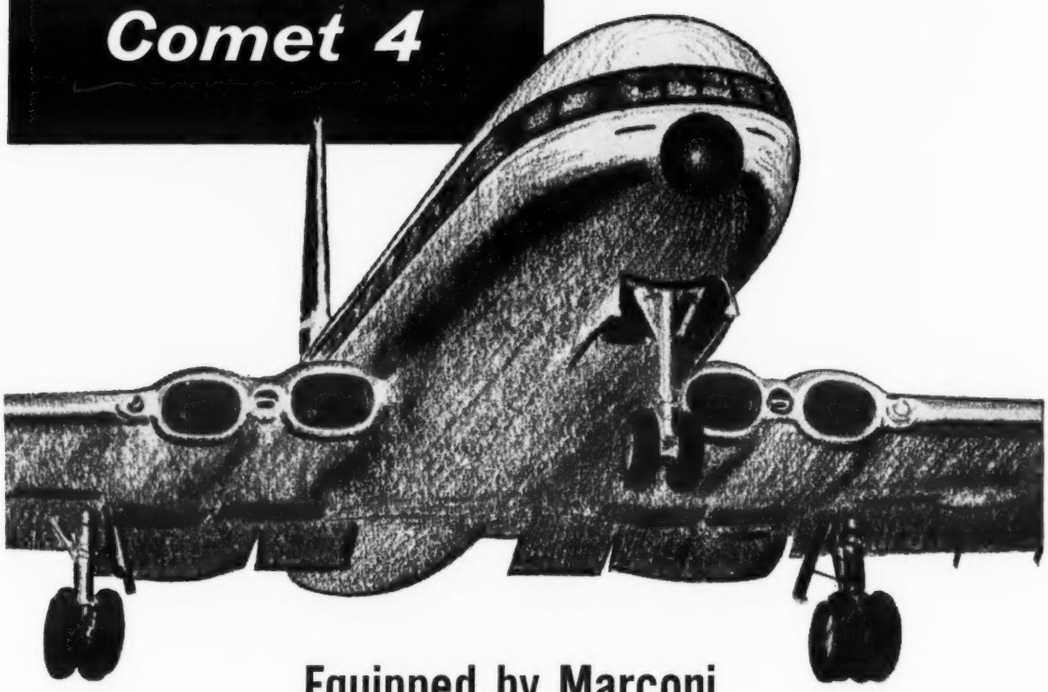




Marconi in the Comet 4



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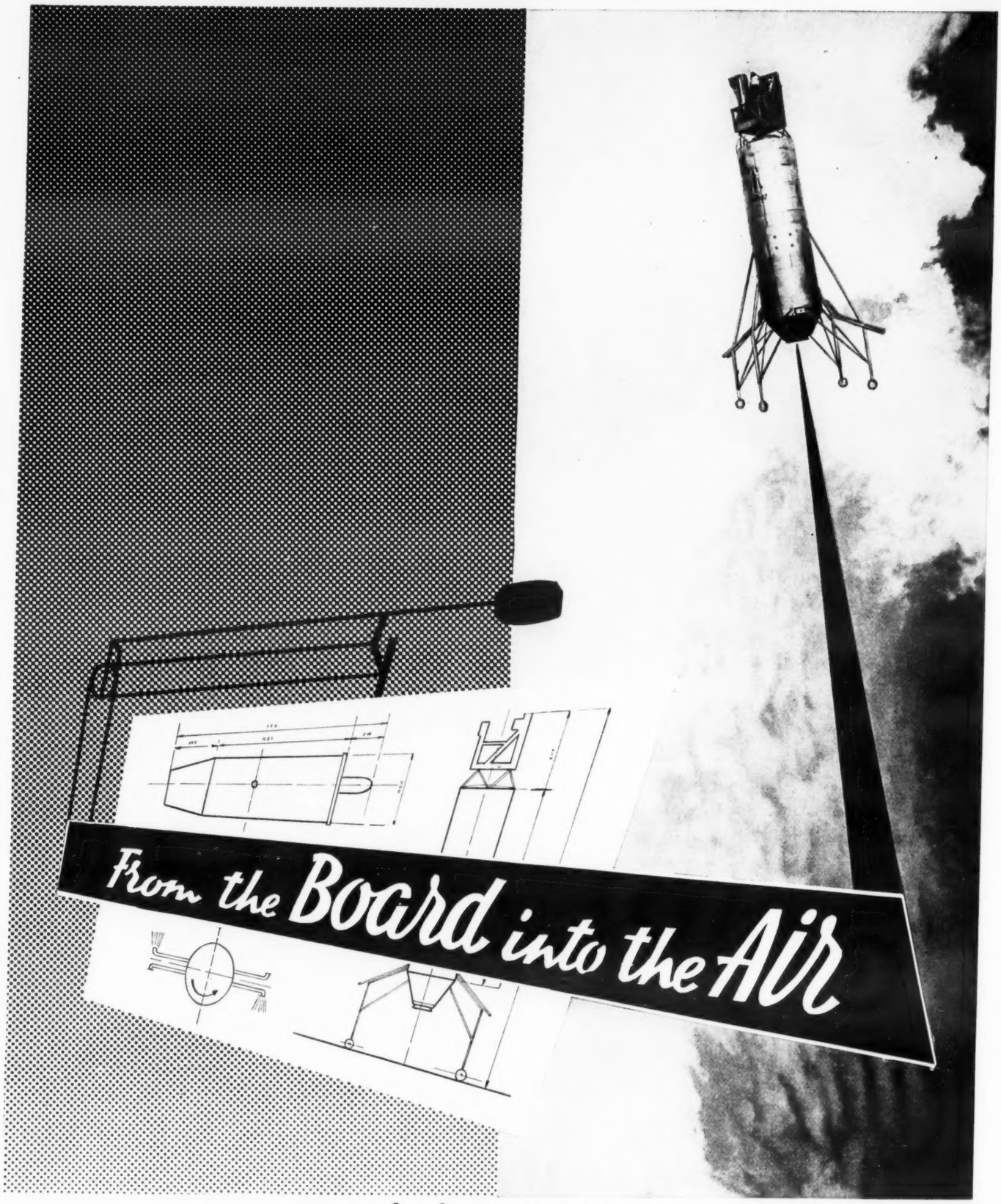

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Union Syndicale des Industries Aéronautiques

The Annual Report of France's Aircraft Manufacturers Association

Last year France's Aircraft Manufacturers Association (Union Syndicale des Industries Aéronautiques) celebrated its first half century of activity. To mark the occasion the Association minted a "forward-looking" medal and organized a number of other festivities.

But the 1957-58 Annual Report issued by USIA Secretary Jean-Noël Adenot contains no traces of this festive spirit. On the contrary, the report presents an unequivocal account, reveals unmistakably what has been ailing the French aircraft industry during recent months and submits minimum demands which must be met if the coming years are to see a greater degree of prosperity.

In the autumn of 1957, not long after the promising 22nd Paris Air Show, states the report, the aircraft industry found itself facing a serious crisis, which has still not been entirely overcome. The French Government's fight against inflation and its efforts to meet international commitments had brought the aircraft industry serious problems.

"The blocking of funds prevented the signature of current contracts and robbed the companies of the normal financing facilities offered by the Caisse des Marchés and the banks... For certain companies, not always the smallest, this almost meant suspending payments. At the same time there were stretch-outs and cancellations of contracts, the economic and industrial impact of which does not seem to have been fully apreciated when the relevant decisions were made. The situation thus created... was improved only after pressing representations by the Union Syndicale and thanks to the understanding shown by the Governor of the Bank of France, the Caisse des Marchés and leading bankers as well as the support afforded by the Air Ministry and the Treasury. Nevertheless the result has been a heavy burden on the companies and a blow to their credit. The uncertainty and anxiety prevailing in aeronautical circles were still further aggravated in 1958."

The situation as regards stretch-outs in contracts and cancellations of work on prototypes and pre-production models is described below. The following were cancelled: 70 Dassault *Mystère SM.B2s*, 20 Sud-Aviation *Vautours* and 11 of the 15 Breguet *Deux Ponts* ordered; in addition work on the pre-production batch of *Tridents* and on the prototype of the *Super-Vautour* was suspended. Production of helicopters, the multi-purpose *Broussard* and certain air-to-air missiles and target drones was slowed down.

Altogether, says USIA, the Air Ministry should have been granted funds totalling 355,000,000,000 francs for 1958 if tasks begun in 1957 were to have been completed. In reality only 317,000,000,000 francs were appropriated.

These economies had been made at a time when, to ensure continued development, an increase in funds would have been necessary. Apparently the French authorities had been influenced by the arguments contained in the 1957 British White Paper, which cut down aircraft production in favour of missiles. In the meantime, however, the French military, like their colleagues elsewhere, had realized that piloted aircraft can never be entirely dispensed with and that—at any rate during the transition period—large numbers will still be required alongside the missiles.

However that may be, the output of the French aircraft industry has fallen off during recent years:

	1956	1957	1958 (early months)
Airframe industry			
Airframes delivered	553	528	approx. 50 a month
Weight, in tonnes	1,536	1,080	approx. 100 a month
Powerplant industry			
Powerplants delivered	1,188	984	approx. 80 a month
Total power in h.p.	4,315,000	3,560,000	

"Fortunately, the share taken in aeronautical activity by the production of the *Caravelle* (27% of the airframe manufacturers involved) and the favourable development of foreign sales have compensated in large measure, and for several companies, the effects of the depression following on the cuts in military orders." As a result of the efforts made during the last decade, exports have risen, more than doubling in value between 1955 and 1957: before 1955, 13,000,000,000 francs; 1955, 14,500,000,000 francs; 1956, 27,400,000,000 francs; 1957, 31,100,000,000 francs.

To round off the picture reference must be made to the fact that many licences have been acquired by foreign companies —an unmistakable sign of confidence in the ability of the French industry.

To spare the French aircraft industry a repetition of the grave situation it faced in 1957-58, USIA calls for a *four-year programme for military procurement* (research and production orders) to be laid down in the form of a law and designed to secure a sound balance between high-performance manned aircraft and guided missiles.

Of course, there is nothing particularly new about such a demand. A similar move, as energetic as it was unsuccessful, was made in the early post-war years—when numerous promising developments got no further than the prototype stage, at best.

A glance through the pages of USIA's history awakens the distinct impression that the French State owes its aircraft industry a high degree of understanding. Even a brief extract from the list of 40 USIA founders will show what is meant: Louis Breguet, De Dion, Robert Esnault-Pelterie, Fernand Lioré, Henry Potez... Up to World War I the French industry led the world by a long head, during that war it turned out 3,000 aircraft a month with a labour force of 200,000, and in 1939-40 a total of 500 per month with a force of 230,000. After World War II it worked itself up from complete devastation to the substantial position it occupies today and has succeeded in regaining for the Paris Air Shows their old status as world forum of aviation... a chapter which should not be passed over lightly.

"Travelology"

From an address by Rein J. Vogels, KLM Director of Public Relations, at the Fourth Public Relations Conference of IATA—Hamburg, November 24th-27th, 1958.

It is an indisputable fact that people from all sections of the community are gradually beginning to desert their familiar haunts from time to time, in order to explore other parts of this planet.

...But how many of these travellers really leave home? How many of them get rid of the iron fetters of daily routine, of firmly rooted ideas and sometimes local narrow-mindedness?

...We cannot blame the Duponts if the blood of a Marco Polo does not flow through their veins. In spite of our luxurious airliners with beautifully furnished cabins, with open and closed sandwiches, with steaks and fillets of sole, with wine and hostesses and sweet music, thousands of these daily passengers are still in an uneasy state of tension and they fail to appreciate the true essence of foreign travel, for which they have paid so much hard cash.

When they are in a Japanese teahouse they become indignant because they cannot buy Chesterfields, in Amsterdam they are upset because there is no pineapple juice at breakfast, the same in Paris because the restaurant proprietor refuses to serve Coca-Cola with his chateaubriand... in New York because they are not used to being addressed with such familiarity, in Padua because they are not allowed into St. Anthony's Church in shorts, and because they think the airlines are responsible for the universal red tape. The great majority of the flying tourists are still embarrassed, irritated, astonished or amused at the wrong moments, owing to a complete lack of elementary knowledge of what I might call "travelology", the art of travel.

...Do we really pay enough attention to making it clear to all those inexperienced tourists, who jointly make up the bulk of our passenger traffic and who represent a tremendous potential for the future, that these are the very things which form the main attraction of foreign travel. I am exaggerating because I want to focus your attention on a subject which in my opinion can be of the utmost importance—especially now that our commercial men are faced with the enormous task of filling the giant airliners.

...At most educational establishments the geography books, and the lessons based on them, are totally inadequate for the world travellers of the future. I therefore earnestly urge that all the governments concerned stress the necessity of teaching the new subject of "travelology"—somewhere in between economics and geography—at all secondary schools and universities. This education will have to provide the psychological background for trips abroad and for meetings with people of other races and colours.

...The requisite steps must also be taken at short notice. It may be possible to convince the publishers of the world's newspapers that a well-edited travel page on the lines indicated is an educational task of primary importance.

...Guidebooks can also be of valuable assistance in this respect, but in that case they must be compiled with absolute objectivity, uninfluenced by facilities and courtesies extended to the authors.

...Perhaps a world-wide plan for activities in this field could be drawn up, to be put into effect with the cooperation of all airlines.

INTERNATIONAL MEETINGS AND CONFERENCES

Jan. 12th : ICAO, Second Special North Atlantic Fixed Services Meeting. Paris.

Jan. 12th-14th : 5th National Symposium on Reliability and Quality Control in Electronics. Philadelphia, Pa.

Jan. 12th-16th : Society of Automotive Engineers Annual Meeting and Engineering Display. Detroit, Mich.

Jan. 13th : IATA Facilitation Advisory Group, 6th Meeting. Rome.

Jan. 16th : Institution of Mechanical Engineers Ordinary Meeting, in conjunction with the Hydraulics Group : " Inherent Non-Linear Effects in Hydraulic Control Systems with Inertia Loading ", by J. K. Royle, and " The Response of a Loaded Hydraulic Servo-Mechanism ", by D. E. Turnbull. London.

Jan. 19th-21st : Helicopter Association of America, 11th Annual Convention. San Mateo, Calif.

Jan. 20th-? : IATA Traffic Conference. Paris.

Jan. 21st-23rd : Southwest Electronic Exhibit. Arizona State Fairgrounds. Phoenix, Ariz.

Jan. 26th-29th : Institute of Aeronautical Sciences 27th Annual Meeting. New York.

Jan. 27th-30th : Society of Plastics Engineers 15th Annual Technical Conference. New York.

Jan. 28th-29th : Fifth Annual Midwest Welding Conference, sponsored by Armour Research Foundation. Chicago, Ill.

Jan. 28th-29th : First International Symposium on Nuclear Fuel Elements, sponsored jointly by Columbia University and Sylvania-Corning Nuclear Corp. New York.

Feb. 3rd-5th : 14th Annual Technical and Management Conference of the Reinforced Plastics Division of the Society of the Plastics Industry. Chicago, Ill.

Feb. 10th : ICAO, Special communications/operational practices and accident investigation/rules of the air and air traffic control and search and rescue meeting. Montreal.

Feb. 12th-13th : 1959 Solid State Circuits Conference, sponsored by the Institute of Radio Engineers Professional Group on Circuit Theory, the American Institute of Electrical Engineers Committee on Electronics and the University of Pennsylvania. Philadelphia, Pa.

Feb. 13th : IME Ordinary Meeting in conjunction with the Applied Mechanics Group " Industrial Ramming of Small High Speed Air Compressors ", by Prof. F. K. Bannister. London.

Feb. 16th-17th : Royal Canadian Flying Clubs Association Annual Meeting. Montreal.

Feb. 20th : Hydraulics Group of IME - discussion " Choice of gas temperature and steam and pressure conditions in nuclear power stations ". London.

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New York Finance Notes

The Growing Importance of the Electronics Industry

BY SCOTT HERSHEY, NEW YORK

The complexity of today's air weapons—both missiles and planes—has brought about wide changes in the defense industry. It is thoroughly entangled with electronics —electronic devices to guide weapons, find targets, detect and defend against the enemy's weapons.

Electronics plays an increasing role in the ever-faster planes. And in the transition from planes to missiles, it takes over the leading role. Immediately the question is raised as to who will control the aero-electronics defense business. Will it be the aircraft manufacturers who were in at the start or will it be the electronic companies that originally were the suppliers, or will it be somebody entirely new such as the rocket engine builders ?

The complexity of today's air weapons also has brought wide changes in subcontracting. A few years ago the subcontracting was mainly in " tinware ", including such things as wing panels, tail and fuselage sections. Now outside specialists, for the most part, provide the intricate systems for fire control and air guidance which depend on electronic devices.

Outlays for electronic equipment for military use in the year ended June 30th, 1958, amounted to about $2.7 billion. In addition to a host of small electronic firms, virtually all of the big names in that industry are in military subcontracting. This group includes such giants as General Electric, Radio Corporation of America, American Telephone and Telegraph, International Telephone and Telegraph, Raytheon, Bendix, American Bosch Arma, Minneapolis-Honeywell, Sperry Rand, International Business Machine, Burroughs Corporation and many others.

The struggle for dominance of defense production goes in steadily for high stakes. The aircraft industry is going into the electronics business, and such an electronics company, for example, as Ramo-Woolridge Corporation, is the systems engineer and overseer of the Air Force's missile projects.

Not many years ago some aircraft manufacturers had difficulty in getting anyone to make the black boxes for the small volume aircraft they had on order. Electronics companies were looking to the television field as potentially more profitable. Many aircraft companies had either to make their own electronic devices or back subcontracting specialists to do the work.

The situation changed rapidly. Electronic devices of various kinds became more and more in demand as the speeds of aircraft increased and electronic devices were needed for a host of flying functions.

Estimates on the cost of weapons systems range as high as 50 percent for electronics in aircraft, and in missiles about 35 percent of spending goes into electronics.

The television manufacturers with technical knowledge and equipment were quick to move into the defense picture. Aircraft companies, in order to maintain their position in the defense picture were forced to build up their own electronics divisions or establish new ones. Sylvania, Motorola and Philco were among the TV makers who began to make their presence felt in the electronics field for defense. And even automobile manufacturers got into the act. Both Ford and General Motors have gone into military electronics and Chrysler is well involved through its missile production.

Among the aircraft companies that got into electronics early are Bell Aircraft and North American Aviation. Both also have started making rocket engines and North American has diversified into nuclear reactors. North American went into electronic equipment because it had difficulty finding anyone who would provide it, and the company has developed a number of devices which now are used by other manufacturers.

Bell has developed automatic landing systems for aircraft combining radar, radio and computers. The company also makes guidance, navigation, flight control, and missile checkout equipment.

Northrop Aircraft has set up a new division, Nortronics, to build electronic systems for missiles and aircraft. Electronics represent about 20 percent of the company's dollar volume.

About one-third of Martin's backlog is in electronics and the company is looking forward to a tenfold increase in the next ten years.

Stocks of electronics companies are selling at 20 to 40 times earnings, compared with six or eight times earnings for aircraft shares, which gives a fairly good idea of what investors think of the future in electronics.

The aircraft manufacturers no longer have a corner on prime contracts, and it is entirely conceivable that the development of future vehicles which are primarily electronic devices with frames designed to house the systems may be managed by electronic companies.

This means that aircraft manufacturers must acquire competence in electronics or take a secondary position. Production of various vehicles has reached a point where every part has to be designed exactly for a given job. The manager of the weapons system is the one who has to coordinate the whole project.

Missiles pose a problem of survival for the aircraft companies. The reason for this, of course, is that much of the finished product is actually produced by others.

The question is posed as to whether aircraft companies go into electronics or should electronic companies take over control of the plane and missile business. Whatever the answer, it is not going to come without a struggle. There are shiftings throughout the military electronics industry and the entire problem is the subject of much sober thought and planning. About the only thing that is certain at the moment is that there is a tremendous future in the electronics field. The stakes are high. The competition is sharp and there are going to be some companies which will fall by the wayside.

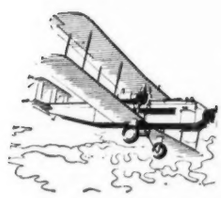
The Defense Department is buying fewer pounds of airframes and expending increasing amounts in the electronic and missile fields. What this means to the wise investor is obvious. But at this time it is difficult to say whether the companies which have been producing airframes—now in less demand—will take over in the electronic and missile fields, or whether they will have to share these contracts with the many non-aircraft companies which are definitely in the field to stay.

Research and development contracts are not too profitable as a rule, unless they lead to production contracts. But it is these production contracts that interest electronic companies who have been producing strictly for the civilian market. Guessing the wants of the market is an inherent factor in civilian production. That factor does not exist in the military market, once a production contract has been let.

However, the Pentagon has been known to cancel contracts and to cut back on orders, and consequently the military market may not be quite as fool-proof as some companies without military market experience seem to think it is.

Meet the New ARGOSY!

WORLD'S FIRST TURBOPROP FREIGHTERCOACH TAKES ON A GREAT NAME IN CIVIL AVIATION



In the story of British aeronautical achievement, some great names stand out: aircraft that made their mark in the skies and helped to further aviation progress.

Such a name is the ARGOSY—the first civil aircraft built by Sir W. G. Armstrong Whitworth Aircraft Ltd., back in 1926. It made history as the first commercial aircraft to pay its way for an airline, and inaugurated Imperial Airways' famous Silver Wing lunch-time service between London and Paris. Economic operations were made possible by its trouble-free maintenance, reliability and carrying capacity.

The new turboprop ARGOSY is the jet-age successor of its famous namesake. And like the old ARGOSY, the Freighter-coach (designated the AW650) will open a new era in air transportation. It is a most versatile aircraft. Not only can it carry up to 80 passengers in pressurised comfort at a speed of 300 miles an hour, it will also open a vast new market in air freight.

The modern ARGOSY carries over three times the load of a Dakota at twice the speed and half the cost.

PERFORMANCE:

POWER: 4 Rolls-Royce Darts.
AIRCRAFT CRUISING SPEED: (14,000 r.p.m.) 296 m.p.h.
MAXIMUM PAYLOAD: 27,000 lb.
RANGE WITH 20,000 lb. PAYLOAD: 1,600 st.m.
SIZE OF HOLD: 46 ft. 8 in. (14.23 m.) x 10 ft. (3.05 m.); floor area 426 sq. ft. (39.6 sq. m.).

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Member of Hawker Siddeley Aviation Division

The ***Argosy*** — BRINGS THE COST OF AIR FREIGHT DOWN TO EARTH

Fastest jetliner in its class – the Boeing 720

The short-to-medium range Boeing 720 has a higher point-to-point speed than any other jetliner in its class.

By increasing the angle of sweep-back of the inboard wing, Boeing stepped up the 720's cruise speed to 614 miles an hour, and its Mach limitation number to .90.

The 720 will carry up to 130 passengers in tourist-class accommodations, and will operate economically over range as short as 200 miles. The 720, moreover, combines the passenger appeal of jet speed and comfort with a lower break-even load factor than any other intermediate-range airliner.

Sister-ship of the 707, the first jet transport certified by the U.S. Civil Aeronautics Administration, the 720 incorporates the unique benefits of Boeing's 707 production experience, as well as design advances based on a continuing prototype flight-test program.

These airlines have ordered Boeing 707 and 720 jetliners:

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Grounded airplanes and lost executive time are among the problems that can be caused by bogus* replacement parts. An increasing number of bogus parts are turning up in the aircraft and engine spare parts supply channels. Counterfeit parts are difficult to detect. They may look genuine but they can still mean trouble.

When a Pratt & Whitney Aircraft engine leaves our plant it's as good as we can make it. It's built to stay that way if properly serviced, using replacement parts that are exactly the same as original parts.

You can protect yourself and your aircraft against the problem of bogus parts by buying from the original manufacturer, from his authorized dealers or distributors, or from recognized, reputable overhaul or maintenance agencies.

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*"*The Problem of Bogus Parts," published by Flight Safety Foundation, Inc. A free copy of this informative booklet may be obtained by writing to Pratt & Whitney Aircraft, East Hartford 8, Connecticut, U. S. A., Attention: Service Manager.*

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At the rate of 1200 gallons per minute, Mobil jet fuel was pumped into this Boeing 707 prior to its first scheduled passenger flight across the Atlantic.

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Pan Am's first transatlantic jet flight used Mobil Fuel

MOBIL HAS A LONG RECORD OF AVIATION "FIRSTS"

Wright Brothers first flight at Kitty Hawk was made with **Mobiloil**

Admiral Byrd, first to fly over the North Pole, used **Mobil** products.

Lindbergh, first to solo the Atlantic, used **Mobiloil.**

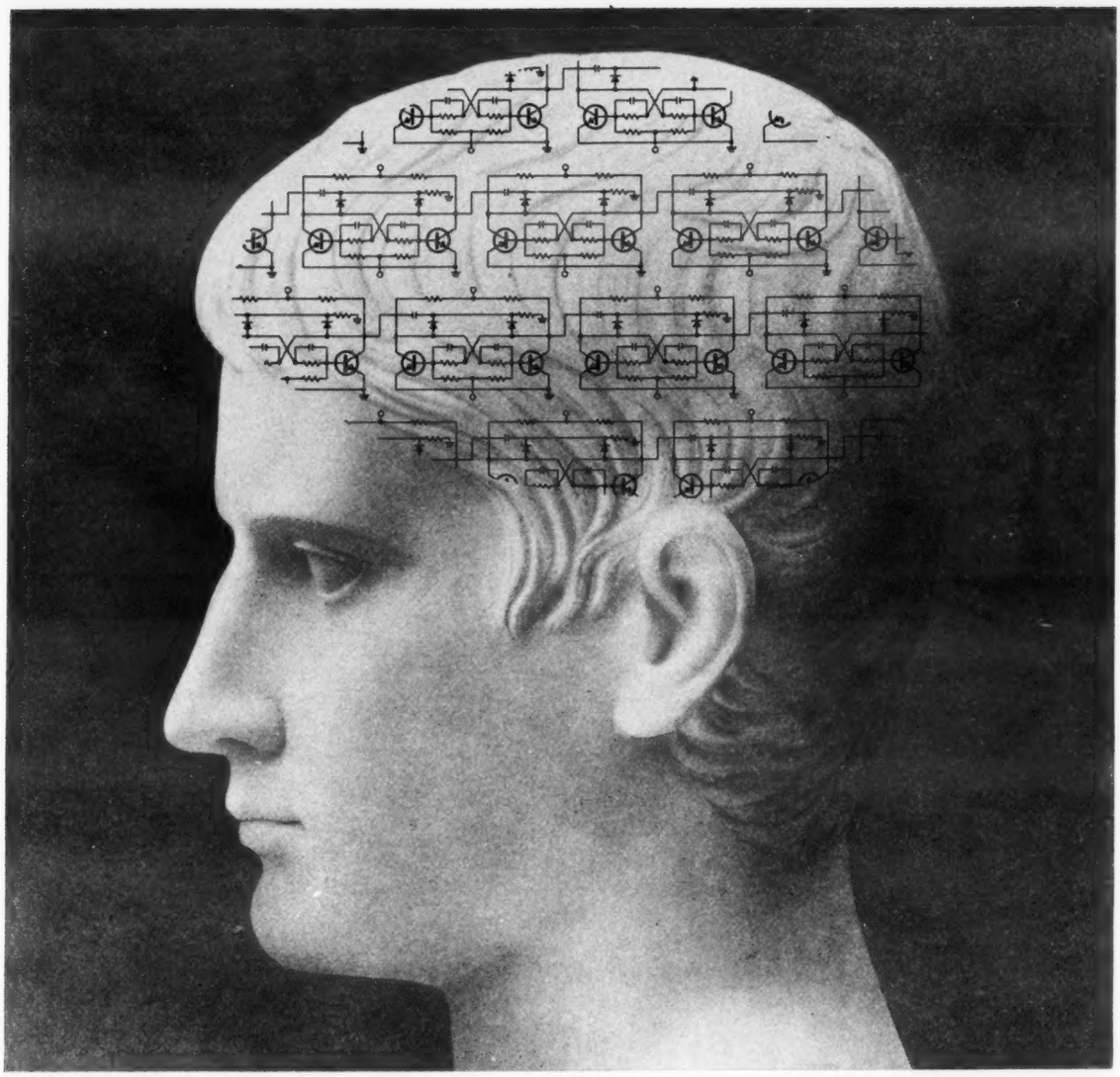
Wiley Post, first pilot to circle the globe, used **Mobil** products.

On October 26, 1958, Mobil became part of still another aviation milestone with the first Boeing jet passenger flight across the Atlantic. The fact that Mobil was chosen to power this flight is a tribute to Mobil research and its ability to develop products and equipment to meet the demands of the Jet Age.

The giant Boeing 707 requires more than twice as much fuel as the largest piston-engine plane in airline service. To meet this need, Mobil equipment was designed and installed — from new storage tanks to new swivel-type, self-sealing wing couplings. Fuel is delivered at a maximum rate of 1200 gallons a minute, so that ground-time for the new jets is no more than for their piston-engine predecessors.

In looking to the future of air travel, the people from Mobil stand ready to meet its needs — with the same experienced personnel, quality products and expert service that have made Mobil famous the world over.

Mobil

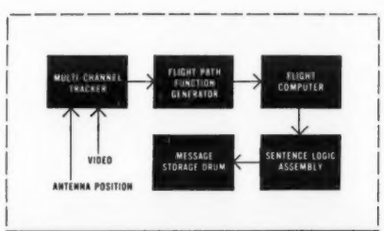


New Gilfillan electronic brain insures air safety!

Latest product of Gilfillan creativity is an electronic brain, an accessory to GCA. It measures, in three dimensions, the *exact* position of an approaching aircraft in relation to the final approach to the runway. The Gilfillan electronic brain then activates a word phrase storage drum, which sends standard voice commands to the pilot so that he may keep his aircraft on the ideal glide path and approach course. The result is greatly improved safety, accuracy and consistency of the aircraft's final approach.

The operator's function in this new flight safety development by Gilfillan is that of a monitor. Automatic voice is adaptable to any language and no additional equipment is needed in aircraft.

Gilfillan's 46 years of experience coupled with creative capabilities in the fields of Air Navigation, Electronic Countermeasures, Missile Systems and Instrumentation, Radar Trainers and Ground Support Equipment, are available for complete research, development and production in these fields.



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now in production for Pan-American World Airways

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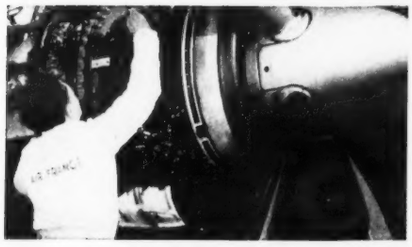
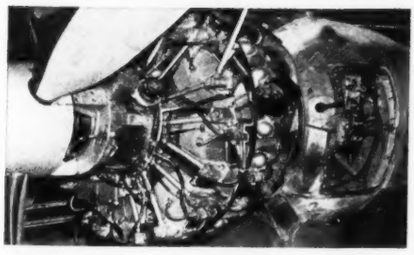
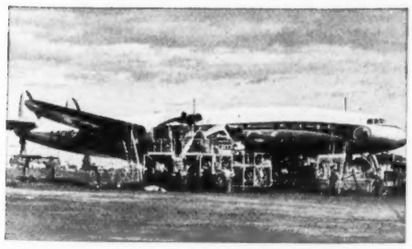
WORLD-WIDE INDUSTRIAL ORGANIZATION







for every take-off Air France presents a new aircraft

In its modern, specially equipped workshops, Air France employs more than 6,000 technicians to inspect and maintain its aircraft.

After every flight, the aircraft coming in from a trip is taken to the hangar where all its essential components are examined. After 50 flying hours the check is even more meticulous. Every 150 hours the inspection takes a full day, and every 1,800 hours 4 days.

Engine, propeller blades, airframe, undercarriage, radio and radar equipment, no part or system escapes the specialists' searching examination.

its far-reaching inspection organization, the size of its fleet and the skill of its elite crews give Air France the qualities which make it the specialist airline in long-distance services.

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THE WORLD'S LARGEST AIRLINE

CANADAIR "ARGUS"

Protecting the power of a hundred-eyed giant...

AUTO-LITE 350 HIGH-TEMPERATURE WIRE

Canadair's huge submarine hunter-killer "Argus" is an electrical giant with an automatic paralleling 400-cycle AC electrical system having a capacity of 160 KVA. More than 5000 separate wire installations use almost 60 miles of wire. In many critical applications where extreme physical and chemical demands are found, the Argus uses Auto-Lite 350 General Purpose High-Temperature Aircraft Wire.

Like many other airframe manufacturers, Canadair finds that the extra temperature range performance of Auto-Lite 350 Wire makes it superior in installations where extremes of heat and cold are a problem. Many manufacturers find that in addition to its high resistance to abrasion, flame, solvents, fuels, and lubricants, Auto-Lite 350 Wire reduces production costs, too, compared with other high-temperature wires.

- **Flexible at temperatures below —80° F.**
- **Smokeless**
- **Resistant to modern aircraft hydraulic fluids, lubricants, and fuels for both reciprocating and jet-type engines**
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GENERAL PURPOSE HIGH-TEMPERATURE AIRCRAFT WIRE

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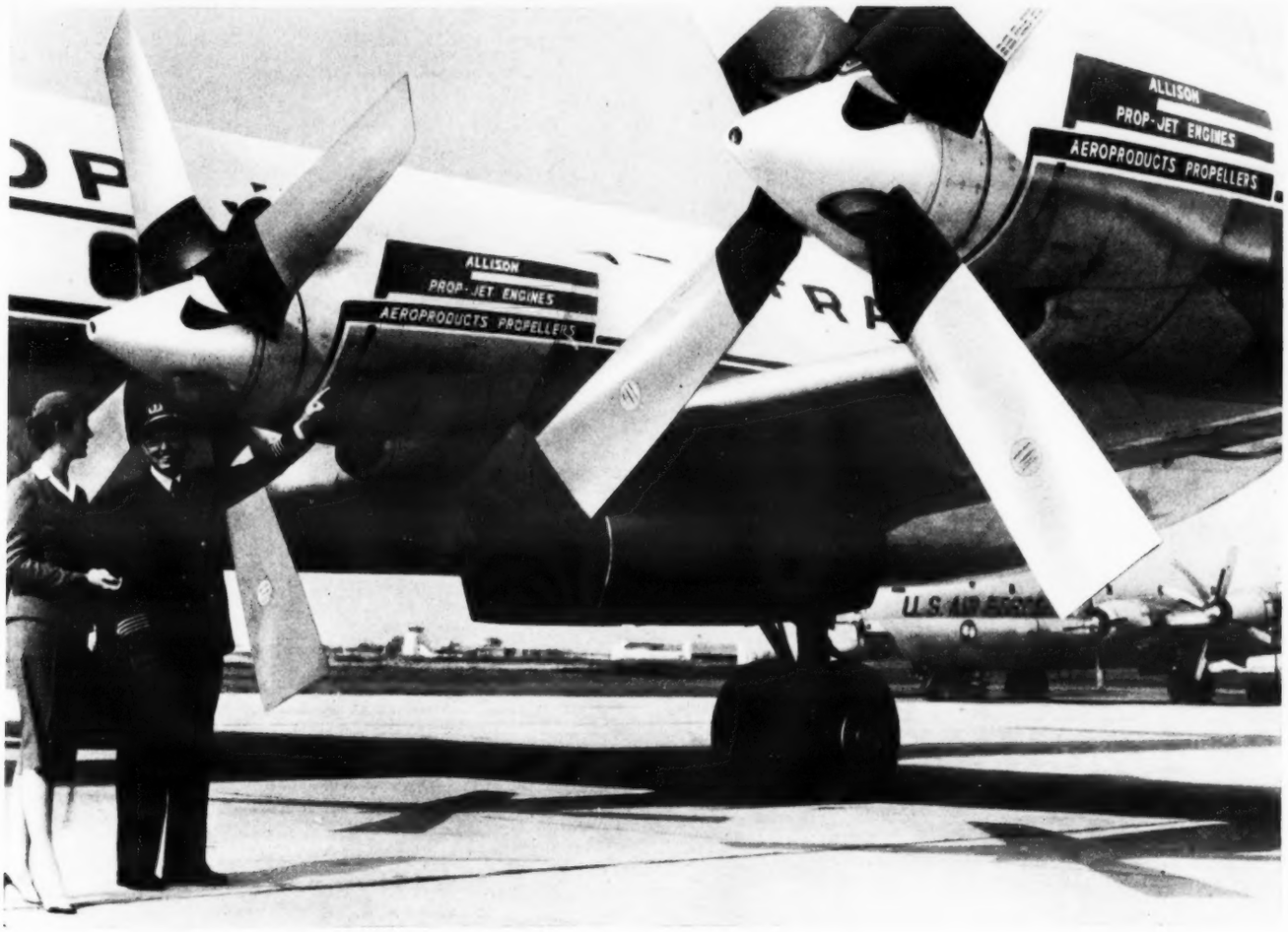

The Allison-powered Lockheed Electra is now joining the jet-age fleets of 15 airlines. It has proved that, in addition to its long-range capabilities, it brings jet-age superiority with economy on short to medium ranges which make up more than 75% of all travel by air.

The greater efficiency of jet-plus-prop provides outstanding take-off, climb, cruise and landing performance. The reverse thrust produced by the Aeroproducts Turbo-Propeller assures positive stops on short, wet or icy runways. Low vibration and sound levels please the passenger as well as the airport neighbour.

The Allison Model 501 prop-jet engine, with its matched Aeroproducts Turbo-Propeller provides a GM jet-power team with performance far beyond any prop-jet powerplant now in commercial service.

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BACKED BY THE WORLDWIDE RESOURCES OF GENERAL MOTORS

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Now... One World Market for the Entire Aviation Industry

A worldwide market for the purchase, sale and lease of new and used transport aircraft over 20,000 pounds has been established by The Aircraft Exchange

MARKET CLOSING – EVERY TUESDAY
MARKET REPORT – EVERY THURSDAY

On January 6, 1959, the aviation industry took another huge stride forward. At 3:00 P.M. on that day the first market closing of the Aircraft Exchange occurred.

Instead of uncertainty as to values, firm price ranges can now be established. In place of world-wide searching for buyers, sellers, lessors and lessees of transport aircraft, firm bids and offers will be brought together simply, quickly and in complete secrecy.

Reminder: If you are planning to send in a quotation to buy, sell or lease transport aircraft please note it must reach the Aircraft Exchange by market closing time, 3:00 P.M. every Tuesday. Regular members may use teletype, international teletype, cable or air mail.

A MUCH NEEDED SERVICE

How much is an airplane worth? Who has aircraft for sale? Where can a buyer be located? Getting the answer to questions like these has cost the aircraft industry untold time and expense. And now, with the coming of the jet age these questions become even more important.

Aviation experts predict that within the next five years most of the more than 4,000 transport aircraft being operated by some 300 airlines will change hands.

The need for a commodity exchange for transport aircraft is obvious. Such an exchange is now a reality.

WHO WILL PARTICIPATE ?

Already organizations on four continents are members of the Exchange.

The rapidly growing categories of membership already include: Airlines Aircraft Manufacturers · Corporate Aircraft Owners · Banks and Banking Firms Insurance Firms · Investment Firms Government Agencies · Airport Managers · Brokers · Dealers · Exporters Importers.

AN AID TO INVESTMENT AND FINANCING

The financing of aircraft has long been a world-wide industry problem. But now, operating under standardized rules and regulations, and with a comprehensive weekly market report, for the first time it will be possible for the world investment and banking community to get a reliable picture of true aircraft values. This will facilitate both the financing of and investment in transport aircraft.

A WORLD-WIDE SALES FORCE

A unique feature of the Exchange is its establishment of a world-wide associate-membership sales organization. This consists of rapidly growing numbers of airport managers, equipment and parts dealers, importers, exporters, aircraft brokers, ship brokers and others who know the aircraft requirements of their local aviation industry.

LOW COST MEMBERSHIP

Designed along cooperative lines, the Aircraft Exchange has rigid limitations on its profits, thus cutting to a minimum the cost of aircraft transactions. The cost of membership in the exchange is limited to not more than $30 a year.

IMMEDIATE INFORMATION AVAILABLE

In order to facilitate the immediate placing of bids and offers. The Aircraft Exchange will air mail full information to any interested organization immediately upon request. Until the Aircraft Exchange's London office is established this month all requests should be sent to the New York address.

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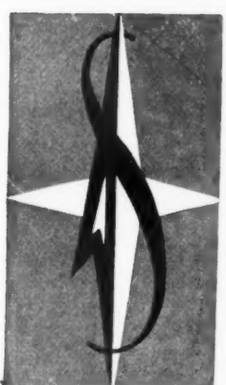
Seven airlines have decided to give the passengers on their services the maximum of comfort and speed. To this end they have chosen

the Caravelle

the ideal aircraft for short and medium stages.



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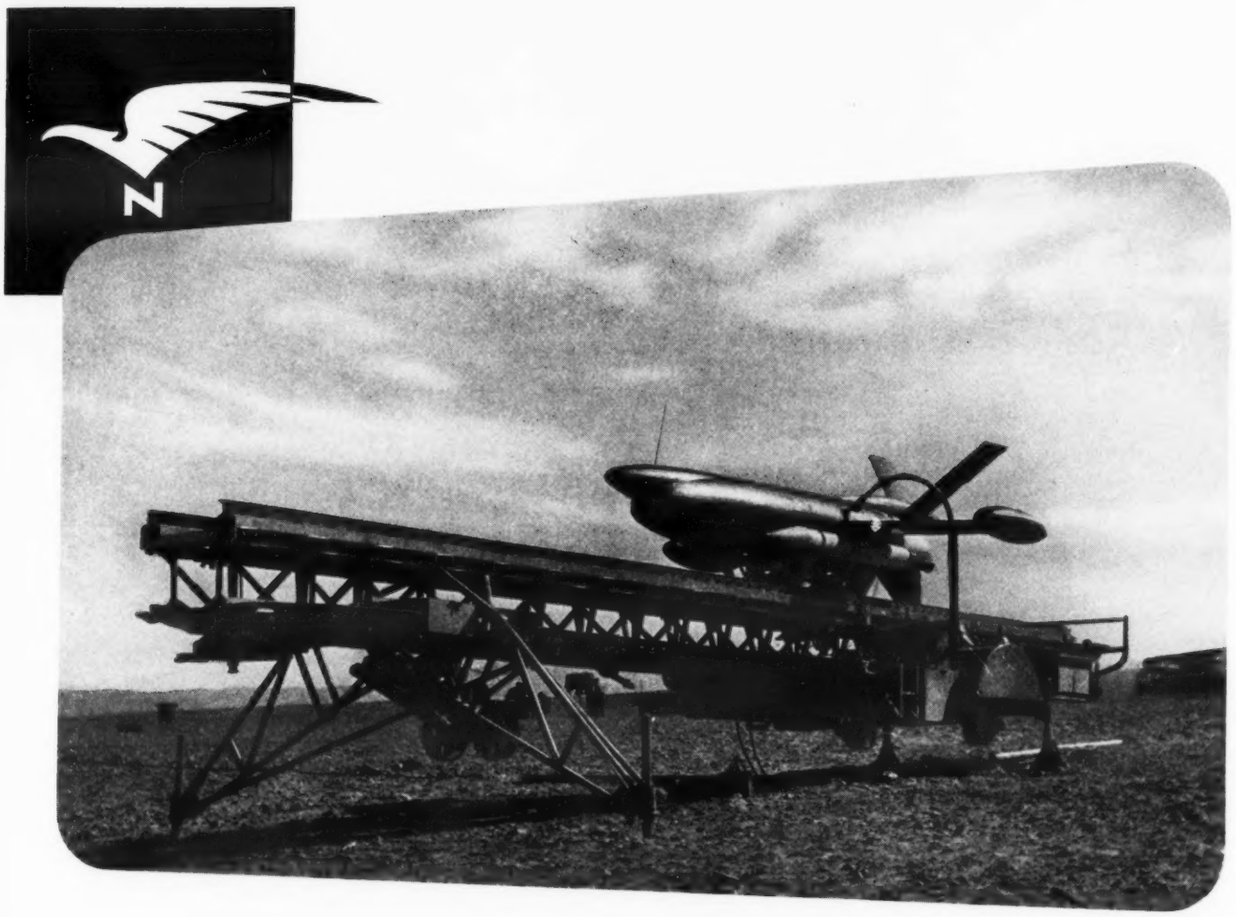

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who also makes the SS. 10 missile

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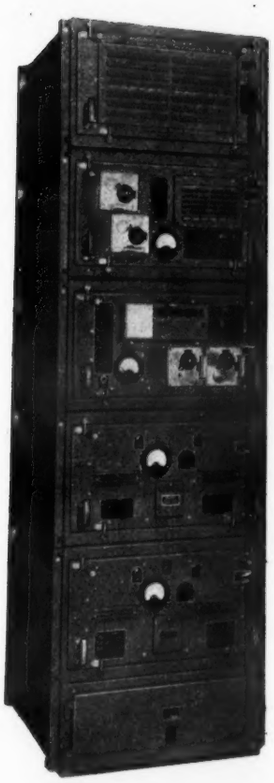
interference free communications on 1750 channels



- Plessey UHF equipment provides clear and reliable ground-to-air and air-to-air communications on 1750 channels.
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proven champion of U. S. Strategic Airlift

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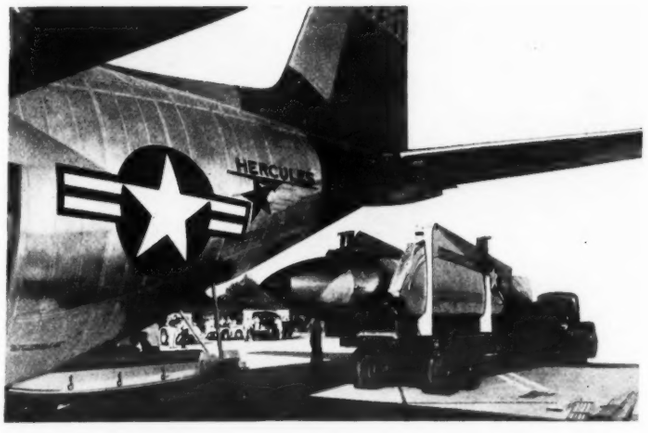
Powered by 4 Allison Prop-jets, the HERCULES can land on or take off from short, rough fields, sand, snow and ice – a capability demonstrated dramatically in 2 years of world-wide USAF service.

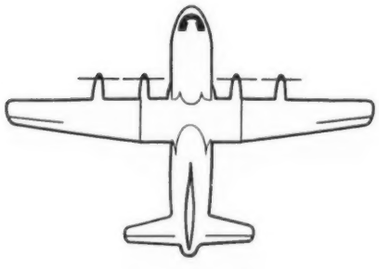
20 tons of pallet-loaded cargo can be winched in or out of the HERCULES *in only 40 seconds* – cutting normal loading / unloading time from 3 hours to 15 minutes or less.

62-tons big, 6-miles-a-minute fast, the HERCULES cruises at altitudes above the weather.

Recent events of world-wide importance have emphasized the unmatched strategic airlift capability of the Lockheed C-130 HERCULES. No other aircraft can do so many personnel/cargo hauling jobs so well, so fast, so economically.



The C-130 HERCULES can carry 90% of all known missiles in operational use today. It flies missile cargoes, support equipment, and personnel 3,400 nautical miles nonstop to launching sites.



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Prop-jet troop transports/air freighters • Jet utility trainers/transports • Nuclear-powered aircraft • Nuclear products aircraft modernization/modification • Ground handling equipment • Missile support equipment

FOR ITS FUTURE DEVELOPMENT POSSIBILITIES...

The ENGLISH ELECTRIC P.1B is one of the most advanced fighters in the world. Even so it is clear that the basic design has further great potential development—not only in performance, but also in adaptation to other operational roles. This built-in stretch offers economies of production and operation, as well as ensuring that, tactically speaking, it can be adapted to meet any situation which may arise.

..THE P.1B IS INCOMPARABLE

'ENGLISH ELECTRIC' aircraft

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Cooperation... with Reservations

The opening article in the January 1958 issue of *Interavia* was headed by a picture of the assembled flags of the North Atlantic Treaty countries, but the title of the article — "End or New Beginning for NATO?"—was less optimistic. The West's "big four" had just managed the month before to give NATO, then in an ailing condition, a "shot in the arm". Twelve months have gone by since then. There is no longer talk of an end to NATO, though the term new beginning would also be slightly exaggerated. However, real signs of improving cooperation between the NATO partners, particularly in the aviation field, can today be detected.

This time there is an optimistic note with which to open the New Year.

*

On the next page of this issue the reader will find an article by a French military writer, who brings a wide knowledge of developments to his judgment of the present situation. A new generation of weapons is on the way for Western Europe—and is once again being provided with American participation. Just the same, times have changed. The Europeans are no longer lining up for free gifts, but most of them are respected customers with hard cash in their pockets. This time they have every right to select what pleases them and what they really need.

In the distribution of million-dollar orders now in progress, some manufacturers admittedly are not receiving their fair share. However, relations between the various national arms industries in the West are today so close that ultimately most companies can be more or less certain of increased activity. The British are exchanging experience and licences with the Italians, Germans, French and even the Americans. Italy is ordering missiles or engines from France and Britain. The Germans have suddenly come out as large-scale purchasers from all the other allies, as they must equip their Air Force, now really in the process of build-up.

The battle for German orders became particularly fierce towards the end of 1958. Representatives of most of the aircraft manufacturers of both Old and New Worlds followed close on one another's heels at the Federal Defence Ministry. There is no need here to list all the companies offering rival designs for the interceptor role; on the one hand, the major developments have already been reported upon, and on the other the reader will find elsewhere in the issue a survey of the various offers and a plausible explanation of why one or the other interceptor was finally rejected, and the Lockheed F-104 won the race. As late as the summer of 1958 it looked almost as if France's *Mirage IIIA* would be victorious, and an article entitled "*Mirage IIIA* in Comparison with the Soviet Suchoy 3a" published in the June issue of the trade paper "Flugwelt" was virtually a message of welcome to this aircraft. Today *Interavia* has no call either to applaud or to register disappointment. At the beginning of this New Year the Editors are happy to note the first signs of true industrial cooperation in the West, even if certain minor national inhibitions still remain to be overcome.

*

Unfortunately another kind of development which has been taking place in the New World since the end of October cannot be ignored here—a development which seems almost incredible in view of the renewed upturn in American business. This is the wave of strikes in the U.S. airline industry.

Roughly speaking, it all began with Trans World Airlines, when 7,000 members of the technical ground personnel went on strike. It continued at Eastern Air Lines, where 550 flight engineers and some 5,500 ground engineers were involved in strikes. According to latest reports, American Airlines must also be prepared for its 1,500 pilots to walk out.

Here the following comments can be made. Although TWA is one of the major airlines, it has been fighting against difficulties for some long time. The company's accounts reveal that it has been operating at a loss for the past two years, and "Time Magazine" for December 1st, 1958 published a pretty sensational report on this case. As is well known, the main stockholder in TWA is industrialist Howard Hughes, with a 78.2 percent stock interest. Only a few years ago this much-discussed personality was regarded as one of the world's richest men, and his total worth was estimated at $800,000,000. Today the situation is vastly different. According to "Time", not all of Howard Hughes' ventures have been entirely happy of late, and he has to find backing for the $320,000,000 his airline has obligated in orders for new aircraft. As already stated, TWA has for some time been running at a loss, and now that it has had to give in to its strikers' demands its finances have not improved.

Of course, strikes by organized labour paid on an hourly basis have become a familiar feature in modern industry. But the situation is very different when pilots, whose top pay has hitherto been $25,000 and who have had to work only at most 85 hours a month to earn this attractive sum, adopt a similar attitude to their much lower-paid ground colleagues.

When the Editors received the first information from their correspondents on the demands put forward by American flight personnel for the jet age, they could scarcely believe their eyes. Their lordships the pilots demanded a maximum annual income of up to $45,000 instead of $25,000, a reduction in flying hours from 85 to 65 per month and an undertaking that the third member of the crew of long-range jet aircraft should be a pilot. Otherwise they would strike . . . The Editors recalled how before the war the American pilots, not yet organized in a union, also came forward with demands for increased salaries; when they applied to the two big labour organizations, AFL and CIO, the latter replied "This is no concern of ours... it's only a fight between capitalists." With an annual income of $25,000 or $45,000, can American pilots really be described as proletarians?

The reports received from the correspondents seemed so far-fetched that further inquiries were made. But then the Editors read in the press that PAA could not operate its full planned schedule of jet flights between London and New York because of pilot trouble, but was provisionally running services using pilot-executives, the supervisory pilots, who are not union members, and who in some cases earn less than the regular pilots. They also heard, though cannot check the story, that one highly paid American pilot on the West Coast completes his weekly quota of flying hours in two days and has time to run a flourishing bank and currency exchange office on the side.

The question now arises of how the jet services are to be operated under these conditions. Theoretically, in order to pay, a modern jet airliner must cross the Atlantic at least twice in every 24 hours, with some 140 passengers or a load facter of at least 60 to 65 percent. Sooner or later, then, more flights and more passenger seats will be offered than hitherto. To fill these giant transports, really new classes of passengers must be attracted. However, this can be done only if fares are reduced. If, however, costs rise—and salaries, particularly for the pilots, form a substantial proportion of total costs—the airlines' finances will begin to look sick, and the future of jet services will be far from rosy.

We began the New Year with optimism, as signs of cooperation between the Western nations are becoming visible. Perhaps the U.S. authorities and the members of the airline industry will also succeed in finding ways to cooperate before new difficulties arise.

EEH

New Weapons for Europe with American Participation

By a Military Correspondent, Paris

The weapons production agreements now being negotiated between Atlantic Pact countries may not all be motivated by the pure "European spirit", but they are of undeniable value.

Ironically enough, the countries which have lost out in these agreements are the very ones which—not so long ago—opposed all plans for European integration on the grounds that their particular interests would not be adequately safeguarded by a supra-national organization for Western Europe.

Britain, for example, has been unable to interest West Germany in her Saunders-Roe P.177 interceptor or her English Electric P.1B heavy fighter. She has also not been successful in finding a European market for her surface-to-air missiles, as the Continental NATO countries have decided in favour of the American *Hawk;* the attitude Britain took to the European Defence Community and today takes to the European Economic Community (Common Market) has not been forgotten.

France, after rejecting the European Defence Community and the joint weapons planning it implied, has quietly ignored the Western European Union which was to have succeeded it. This country has just lost to Italy the market for the lightweight strike fighter. It has also lost the market for the Mach 2 fighter, which has gone to the United States, with the Lockheed F-104.

Here West Germany, with its hard currency, plays the role of arbiter, and the United States and Italy have benefited from the disagreements between Europe's two biggest suppliers of military equipment, Britain and France.

The dream of a united Europe becoming progressively capable of supplying all its own defence needs, with weapons jointly developed and produced, is vanishing. Though the source of so many ideas and technical innovations, Europe is more than ever dependent on the United States.

Only a few years ago the United States made a free gift to Europe of hundreds of millions of dollars' worth of equipment. Through its policy of "off-shore" orders, it paid out hard cash to encourage technological development in Europe. Today, all the European countries who can do so are buying American licences or material, now that the Mutual Defense Aid Program gifts have ceased and "off-shore" orders are tapering off. In the technical field as in that of financial aid, the United States is winning: American technology is being implanted in Europe, and the cost of this implantation is decreasing.

The agreements under discussion in this early part of 1959 will inaugurate a new technical direction which will hold good for a number of years or at any rate for the present generation of weapons. What are these agreements? There are at least six which will have major repercussions in the European weapons field and on the activities of the European aircraft industry.

❶ At America's suggestion and with the backing of French experts, the Raytheon *Hawk* surface-to-air missile will probably become the standard missile for air defence over short distances and against low-flying aircraft. Sud-Aviation will reportedly manufacture the missile body in agreement with Fiat. German and French electronic companies will reportedly take over responsibility for its electronics. But Philips and Fokker, both of Holland, are also claiming a share in manufacture. The deal is obviously a very big one, since thousands of these missiles will be required, complete with handling and testing equipment. Under present plans, battalions of *Nike* missiles supplied by the United States are to be deployed in Europe, from the North Cape to Turkey, while hundreds of *Hawk* batteries wil be installed in parallel to stop up the gap between ground level and the 13,000 to 16,000 ft. altitude at which the *Nike* is operationally utilizable. The *Bomarc,* which Boeing has proposed to the European countries, has been turned down by French Army experts on the grounds of its complexity, high cost and range which exceeds what is required for European defence. If, with Raytheon's aid, tens of thousands of *Hawks* are made by Italian, French, German and Dutch companies, this will be an undoubted victory for American technology and at the same time help to standardize anti-aircraft weapons. But Britain will not obtain from Europe the recognition due to the size of the technical and financial efforts she has made in the matter of defence missiles.

❷ At America's suggestion, the Fiat G.91 was selected as "first generation" lightweight strike fighter. West Germany played a deciding role when she announced that she would buy fifty of these aircraft from Fiat and herself build another 150 under licence. Italy has also ordered a batch for her own use. Greece and Turkey, both of whom have strong ground forces requiring air support, will also probably take G.91s, but with American financial aid. Thus a total of nearly 400 of these aircraft, fitted with the Bristol *Orpheus* jet, will be built by Italy and Germany. Italy's success in this field is undeniable, and Bristol has an assured market ahead.

On American recommendation, backed by French experts, the Raytheon *Hawk* surface-to-air missile is under consideration as standard weapon for air defence over short distances and especially against low-flying aircraft. Left: a group of three *Hawks* being transferred from the carrier vehicle onto the launcher: right: in fire position.

Latest F-104C version of the Lockheed *Starfighter* multi-purpose fighter, as operated by the USAF's Tactical Air Command. The German Air Force has decided to procure a substantial number of modified Lockheed F-104As.

France, who submitted four different aircraft for the tests in September 1957, lost the first round. She had, admittedly, put forward her own ideas for a lightweight strike fighter, in competition with the SHAPE programme, namely her twin-jet models, since abandoned. It is also true that in entering *Atar*-powered aircraft in the contest she had not only alienated Britain, but also gone back on her own decisions, since her delegates to the NATO Lightweight Strike Fighter Committee had agreed that the *Orpheus 3* jet should be accepted as standard engine. These inconsistencies did not facilitate the task of her negotiators when they were endeavouring to obtain American financing for a pre-production batch of the Breguet *Taon*, which, equipped with the more powerful *Orpheus 12*, was to become the "second generation" aircraft.

After studying the problem, the Pentagon decided to go straight on to a "third generation", represented by a more advanced model capable of near-vertical or short take-off. The fact that the Mutual Weapons Development Team is financing a new high-performance Bristol engine, with orientable jet stream, has enabled Hawker to re-enter the contest from which Britain had been eliminated in 1954 when the Avro aircraft designed to meet the "first generation" specifications was abandoned. And it is an amusing paradox to find today that Britain is well placed in the contest for the supply of lightweight strike fighters for the "third generation", when only a short time ago she stubbornly refused to see any value in this category of aircraft.

In fact, the perseverance shown by SHAPE and NATO has ultimately triumphed over national rivalries, and 1959 will see production lines set up for several hundred Fiat G.91 light fighters. The beneficiaries of this project will be the Italian and German industries, and to a certain extent Britain.

❸ The question of military cargo aircraft is also on the agenda. It would have been possible to take the Lockheed C-130, either buying it in the United States or manufacturing it under licence in Europe. The new generation of British transports could also have met Western Europe's future logistic requirements. But, under the tripartite agreements concluded between the De-

Most of the European NATO countries have chosen the Fiat G. 91 as standard lightweight strike fighter.

The first CM-171 *Magister* twin-jet trainer (Fouga licence) built by Flugzeugunion Süd (Messerschmitt-Heinkel) leaves the Messerschmitt AG final assembly shop.

fence Ministers of West Germany, Italy and France at the end of 1957, it was decided that two cargo aircraft should be developed and built in Continental Europe.

The original idea was that Germany should be responsible for the development—and perhaps the full production—of a military transport for an 8-to-10 ton payload, while France should assume the same responsibility for a lighter type, for which the Breguet *Intégral* might serve as model and flying mockup. Since Germany has rejected the *Mirage III* and France has refused to take the 48 Fiat G.91s it was to have ordered if the Breguet *Taon* had been selected as the "second generation" strike fighter, it is doubtful whether much will remain of these proposed agreements. The result is rivalry between France and Germany over the project for cargo aircraft of 8-ton payload, with Britain supplying the engines. Here too, a decision will probably be made during the course of the year.

❹ The difficulties encountered in organizing the production of a European lightweight strike fighter have not entirely discouraged NATO. A new "integrated" project has been launched, this time for the development and production of a naval patrol aircraft to replace the Lockheed *Neptunes* in Europe. Originally, as in the strike fighter project, the idea was to use purely European resources, with Britain providing the engines and the Continental airframe manufacturers grouping together to build the some hundred aircraft required. But certain American manufacturers asked to be admitted to the contest. Lockheed pointed to the U.S. Navy order for a naval version of the *Electra*. Douglas argued the advantages of "navalizing" the commercial DC-7, which is outclassed in airline operation by the Boeing 707 and Douglas DC-8 jets. This project is also backed by Britain's Napier, who propose the *Eland* turboprop as powerplant. At the same time the European manufacturers, grouped together in threes or even fours, submitted their projects, and the group headed by Breguet was selected. Matters are following their normal course, and the Breguet project could be launched shortly if it were not for the financing problems. Obviously neither the Benelux countries, nor Italy, nor France can afford to buy aircraft costing more than two million dollars apiece, particularly when these aircraft are designed for a secondary role. Help would have to come from the United States, but Uncle Sam is obviously not particularly interested in financing a project from which his own industry—and taxpayers—will in no way benefit. Nevertheless some decision will have to be made this year, whether it is to maintain the *status quo* by keeping the *Neptunes* in service, to adopt an improved model of the *Shackleton*, to take the *Electra* or the DC-7, or to build the prototypes of the Breguet model which has been designed especially for the contest. Needless to say, the French company would not be happy if yet another of its successful designs were rejected.

❺ The question of intermediate range ballistic missiles for Europe, i.e., missiles capable of hitting targets from 1,500 to 1,800 miles away from their launching sites, concerns both the United States and the European countries. Britain is receiving *Thors* as an interim solution, under a bilateral agreement with the United States. After similar negotiations, Italy is to get *Jupiters*. These missiles are, of course, under dual control—American and British or Italian. Under the Paris Treaty the German Federal Republic is precluded from possession of similar weapons, even under dual control. For her part, France plans to have ballistic missiles, but has so far refused to share their control with the Americans and wants to make her own. But her backwardness in this domain can be measured in years and millions of dollars. Hence, if she is to engage in the development and production of such missiles, it will probably have to be under bilateral technical agreements with the United States. This is yet another field in which positive steps must be taken before the end of the new year.

❻ The year ahead will also see the practical implementation of the Americano-German agreement covering the manufacture of the Lockheed F-104 in Germany. If the aircraft ultimately produced by the German industry is slightly different from those which are flying today, it will have been adapted more closely to meet the needs of European defence and, consequently, will see additional markets opening to it both inside and outside Europe. After an eclipse of some fifteen years, the German aircraft industry will be in position to enter the world market again, thanks to the qualities of the General Electric J79 engine and of the very advanced Lockheed airframe.

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All these negotiations and agreements confirm the power of American technical progress. Secondly they reveal a return to the practice of concluding bilateral agreements and the abandonment of earlier principles of "integrated" projects among purely European countries. Europe will probably not be united in the weapons field until a new generation of armaments comes along and until the German industry has developed sufficiently to give the Federal Republic an authority which it does not yet possess in this domain. How much ground has been covered since 1950 and the early projects for European integration! The prospects opened up by the Common Market have led to an intensification in the sales efforts of American manufacturers, who have no desire to see Europe closed to their products. Dissension between the European countries has done the rest, and these two developments have created a new situation which both industrialists and military planners must take into consideration.

A Douglas *Thor* IRBM—handed over to RAF Bomber Command by the USAF's Strategic Air Command—arrives at a bomber base in Norfolk *(top picture)*, where British crews are being trained in the handling of the weapon by American officers. *Lower left:* anyone approaching the mobile *Thor* launching platform is received by a police dog with highly "official" manners. *Lower right:* the four-axle trailer used to transport the *Thor* from the depot to the launching base measures more than 90 ft.

THE LOCKHEED F-104

MULTI-PURPOSE FIGHTER

IN NATO'S ARSENAL

The Lockheed F-104 *Starfighter* was conceived in November 1952 as a supersonic air superiority fighter for the USAF's expeditionary units and was originally to have been armed only with fixed weapons – in particular the General Electric *Vulcan* six-barrel 20-mm cannon – and equipped with efficient radar sight. An experimental model, the XF-104, was developed and built to this design during the following 15 months. The first prototype made its first flight on February 28th, 1954 and, together with the second prototype, underwent extensive tests and modifications until autumn 1955.

Meanwhile, however, the USAF had changed its programme, presumably in part as a result of the cessation of fighting in Korea and Indo-China on the one hand, and in part because of the introduction into service of Russia's *Bison* and *Bear* long-range bombers. The military now wished to operate the F-104A production model of the *Starfighter* as an *interceptor* with limited all-weather capability, and to include it in the NORAD (North American Air Defense Command) home defence squadrons. This meant expanding the electronic equipment and arming the aircraft with air-to-air missiles (*Sidewinders* with infra-red homing guidance). The first F-104A modified to meet these requirements took off on its maiden flight on February 17th, 1956. Today it is in quantity production, and substantial numbers have already been delivered to the USAF, where they equip the 83rd Fighter-Interceptor Squadron at Hamilton AFB, California, and a number of expeditionary units in the Far East.

Next, early in January 1957, the first *F-104B two-seat version* began flying and later went into production. Designed primarily for pilot training, this version can also be employed on combat missions if required.

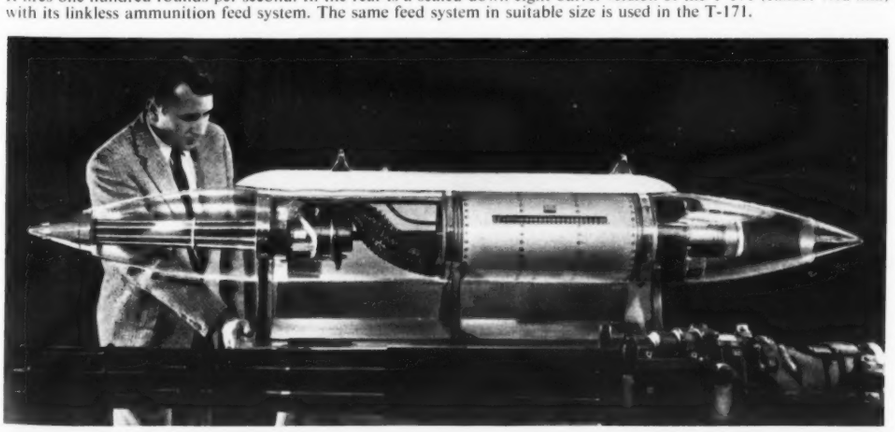
Meanwhile the USAF's Tactical Air Command, which is also responsible for watching the interests of the U.S. expeditionary air units, had renewed its claim for this aircraft, since it had originally been designed as a tactical weapon. TAC insisted that the F-104 should be employed in its original role as *air superiority fighter – and in a new role as long-range fighter-bomber* – and in this plan found a willing ear and energetic support at Lockheed. This led to the latest version of the *Starfighter*, the F-104C, with provision for the carriage of external armament, two or four auxiliary fuel tanks and/or air-to-air missiles, plus interchangeable electronic equipment to meet different operational requirements. The F-104C – and perhaps other models – is equipped for in-flight refuelling (see cover picture), so that it can take its place in TAC's Composite Air Strike Forces or operate singly over very long ranges. General O. P. Weyland, Commander of TAC, had the satisfaction in mid-October 1958 of officially accepting the first F-104C at Nellis AFB, near Las Vegas, Nevada, on behalf of the USAF and his Command.

Other *special versions of the F-104* are also under test or development:

- The RF-104A reconnaissance model.
- Modified versions of the F-104A, more closely adapted to particular operating conditions or control procedures. Included here are a number of structural modifications designed to enable the F-104A to be used *if necessary* for direct support of the ground fighting in the combat area (low-level operations), a role for which it was not originally developed.
- An advanced development of the F-104C (namely model 683-5) with improved electronics and all-weather armament: in addition to *Sidewinder* infra-red missiles (which are inefficient in cloud and sometimes turn into the sun), air-to-air missiles with radar homing heads or (e.g., against bomber formations) atomic-warhead missiles.

Thus in its brief six-year history the Lockheed F-104 has developed from a pure air superiority

The General Electric T-171 *Vulcan* six-barrel 20-mm cannon seen in the foreground, is standard gun on the F-104. It fires one hundred rounds per second. In the rear is a scaled-down eight-barrel version of the T-171 (calibre 7.62 mm) with its linkless ammunition feed system. The same feed system in suitable size is used in the T-171.



A Lockheed F-104A *Starfighter* has just fired its two Philco-General Electric *Sidewinder* infra-red homing missiles (outlined in white) against an aerial target. The rockets start off under their own power from locks at the tips of the wing (barely recognizable here) and automatically track the heat radiated by their target.

fighter via an interceptor to a very versatile multi-purpose single-seat combat aircraft which is capable of tackling the full range of military missions in cold or hot war and will probably retain this capability for some years to come. These missions can be described as follows:

1. Protection of the home airspace in times of political tension: In periods of cold war the adversary can be expected to use high-speed aircraft for reconnaissance or nuisance penetrations (e. g., dropping leaflets) without engaging in armed conflict. At the same time it is important to avoid a situation in which high-speed friendly airliners whose crews have failed to report or have strayed from course are shot down out of nervousness by the home air defences. It may therefore be necessary to send up *two* high-speed fighters to investigate the unidentified intruder

Dimensions, Weights and Performance of the F-104A

Powerplant: One GE J79-GE-3 with afterburner of 11,000 lb. dry thrust or 16,000+ lb. with afterburner.

Dimensions:

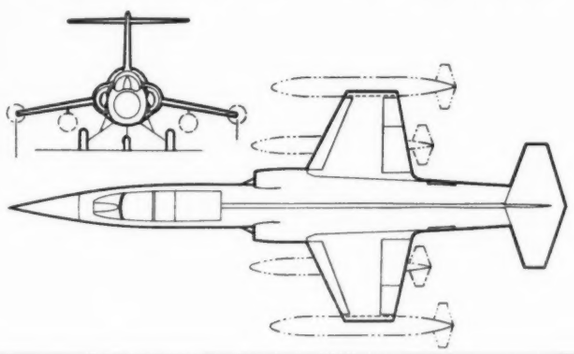
Length	54.7 ft.
Span	21.9 ft.
Wing area (gross)	196.1 sq.ft.
Wing area (net)	120 sq.ft.
Area of tailplane	48.1 sq.ft.
Thickness/chord ratio	3.36%
Leading edge radius of curvature	0.016 in.
Negative dihedral	10°

Weights:

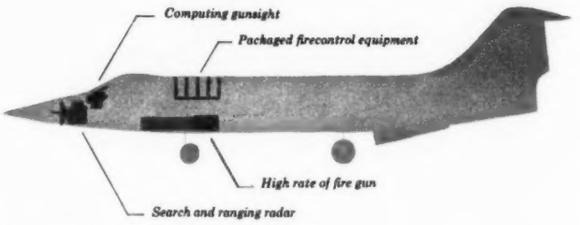
Normal take-off weight (internal fuel only)	approx. 17,000 lb.
Take-off weight with two wing-tip tanks	approx. 20,000 lb.
Take-off weight with two wing-tip and two under-wing tanks	approx. 23,000 lb.
Overload take-off weight (Special version)	27,000 lb.
Normal landing weight	11,500 lb.
Maximum landing weight	13,900 lb.

Performance:

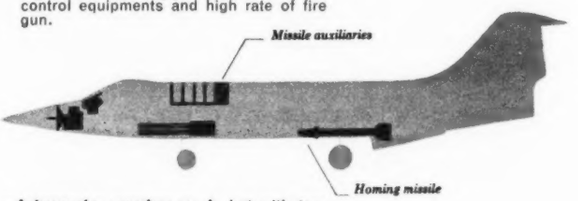
Maximum speed equivalent to	Mach 2.2—2.3 at 34,000 ft.—52,000 ft. altitude
Touchdown speed	135—140 knots
Landing approach speed	approx. 200 knots
Take-off taxi run with normal take-off weight	3,000—4,000 ft.
Maximum rate of climb at sea level	approx. 660 ft./sec.
Time of climb to 36,000 ft. (with afterburner)	approx. 1.2 min.
Range without external tanks	approx. 700-750 nautical miles
Range with four external tanks (ferry flights)	approx. 1,900+ nautical miles



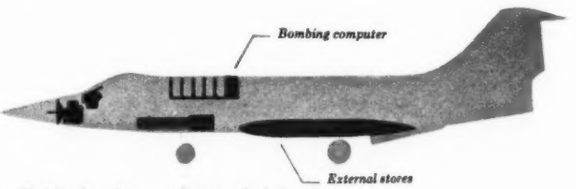
Weapons Combinations for the F-104



A — **Day fighter version** with search and ranging radar, computing gunsight, various fire-control equipments and high rate of fire gun.



B — **Interceptor version** as A, but with two infrared air-to-air rockets and relevant equipment.



C — **Fighter-bomber version** as A, but with auxiliary fuel tanks, bombs and bombing computer.

The two-seat F-104B version is designed primarily for pilot training, but can also be used for combat missions if required.

and decide, depending on the situation, to (a) allow it to continue unmolested, (b) force it to land, or (c) shoot it down. Two fighters are required, since if the unidentified aircraft has hostile intents a single fighter could only either identify it or shoot it down . . . but not both in the correct sequence. In this way, however, the two pilots share the task: one flies wing with the intruder, identifies him and signals; the other flies above and behind in firing position. Obviously the alerted or patrolling F-104 "identification fighters" would have to work in close contact with the air surveillance radar network and the air traffic control service. With efficient ground control, Lockheed has calculated that with their high top speed (Mach 2) they could intercept a Mach 0.9 intruder not further than 60 miles from the frontier, provided they were both in the air at the time of the penetration and were not more than 100 miles away from the point of intrusion. If the adversary used supersonic aircraft, the meeting point would be further inland; in practice, however, there would be little question of identification in such cases, as any unannounced unidentified intruder penetrating at supersonic speed would always be regarded as unfriendly.

2. Permissible reconnaissance in peacetime: Provided an aircraft does not penetrate into the "other side's" sovereign airspace, but remains in its own or its allies' airspace or over the open seas, it may not be fired upon. Lockheed points out that the F-104 holds the world's altitude record for aircraft operating entirely under their own power, with a figure of 91,249 ft., and can carry long focal length cameras, which if used at very high altitude can reach far into the other country's territory.

3. Probing missions in the cold war: Although not permitted under international law, probing missions into the adversary's territory are nevertheless sometimes carried out, (a) in retaliation for similar missions by the other side; (b) to keep the adversary in a constant alert status, thus wearing him down; (c) to drop leaflets; (d) to ferret out important details of radar networks, missile batteries or other military installations. The prime rule in probing missions is to avoid identification and to evade the adversary's fighter defences by rapid escape. Thanks to its high top speed at high altitude, the F-104 can penetrate up to 250 miles into adverse territory with a good chance of survival.

4. Interception: In a "luke-warm" or "hot" war identification missions are replaced by interception. All aircraft penetrating into the airspace without correctly reporting will immediately be treated as "hostile" and attacked, whether they are relatively harmless reconnaissance and intruder aircraft, fighter-bombers or tactical and strategic long-range bombers. When manned aircraft are used for interception purposes—and in the event of a major war they would be supported by surface-to-air missiles—the most likely procedure will be to rely on alert take-offs from checkerboard bases, as this method is less costly in fuel and nerves—than permanent patrol flights. With its high rate of acceleration from take-off to supersonic speeds, its impressive rate of climb and its armament with homing missiles, the F-104 has a very great kill probability. It engages its opponent on a pursuit course from the rear and has the necessary speed margin over most of the operational aircraft (except fighters) now in service with the Eastern *bloc*. Obviously interception is most effective if the enemy bombers or fighter-bombers are engaged before they reach their targets. However, it is still valuable even after bombs have been dropped—particularly in aerial warfare with conventional weapons—if it inflicts heavy losses on the enemy (attrition).

5. Aerial combat: In any localized conflict or in global war the airspace above the friendly ground troops, their strike aircraft, air or naval units, would have to be kept clear of enemy fighters. Needless to say, this presupposes that the friendly fighters hold a tactical superiority over the enemy's. It is now presumed that future air battles—between supersonic fighters—will no longer be fought out with guns, but with *air-to-air missiles*. These battles will probably occur at very much higher altitudes than has previously been the case

First in-flight picture o the F-104C: the slats and flaps are shown extended, and the firing aperture for the T-171 *Vulcan* 20-mm cannon is clearly visible beneath the pilot's cockpit.

Looking down the afterburner of the General Electric J79 jet engine in the *Starfighter* (two-seat model).

The razor-sharp tail unit on the two-seat model (with deeper rudder).

Left main undercarriage unit (and landing searchlight) of the F-104A.

The F-104 wing (thickness/chord ratio only 3.36 %) carries leading edge slats and trailing edge flaps.

The world's highest-flying and fastest fighter pilots: Major Howard C. Johnson (left) holds the FAI's international altitude record for aircraft, at 91,249 ft., set up on May 7th, 1958 by using kinetic energy stored during high-speed flight at medium altitudes. Captain Walter W. Irwin (right) attained the world's absolute speed record of 1,404.19 m.p.h. on May 16th, 1958, over a 10.1-mile stretch 40,000 ft. high. Both pilots flew an F-104A *Starfighter*.

Why Germany Chose the Lockheed F-104

No official statement has yet been made by the Federal Defence Ministry explaining the reasons why the F-104 has been chosen as Germany's standard multi-purpose fighter for the next seven to ten years, nor is it likely that any such statement will be made in the near future. However, it is possible to reconstruct a picture of the situation, with some degree of reliability, from earlier pronouncements by the authorities reponsible for the build-up and equipment of the new Luftwaffe. It was clear from the outset that the German military authorities would decide on not one but two basic types of jet-powered single-seat combat aircraft:

1. A supersonic model for medium altitudes, capable of utilization as day fighter, all-weather fighter, fighter-bomber and reconnaissance aircraft, to replace the various models of the F-84 and F-86.

2. A sonic-speed model for direct support of the ground troops, i.e., for low-level strike and close reconnaissance missions.

Pure high-altitude interceptors, such as are employed by the North American Air Defense Command and the Royal Air Force, were rejected *a priori* because of the lack of depth of West Germany's territory and its proximity to Warsaw Pact countries. High-flying strategic bombers, particularly those operating at supersonic speeds, could be combated only from further back in the Western European area, i.e., from bases in Britain and France. On the other hand the single-seat combat model selected under requirement No. 1 above had to be capable of employment against tactical bombers and fighter-bombers, even of supersonic speed, while the strike fighter mentioned under point No. 2 must rely on dispersion and camouflage to evade the enemy. As is known, the Fiat G.91 has been chosen for the second role.

Why the F-104 won the contest for the first role can be deduced without excessive perspicacity from the general situation:

- The Convair F-102 and F-106, the USAF's typical high-altitude interceptors, would have been too heavy and too costly for the given task.
- The English Electric P.1B *Lightning* likewise, since it is a twin-jet model.
- Neutral Sweden's Saab J35, though considerably lighter in weight than the types already mentioned, was also not included in the short list.
- The Dassault *Mirage IIIa*, the prototypes of which did not begin flight testing until 1957, is reportedly not yet fully developed as regards electronic equipment.
- The Grumman F11F-1F *Super Tiger*, which has been flight testing since 1958 and is probably the technical equal of the F-104, appears to have been handicapped by its considerably shorter development history and would probably be more expensive to buy than the F-104.

What the Luftwaffe wanted was a multi-purpose single-seat combat aircraft best suited for combat altitudes up to 50,000 ft., well proven and of minimum possible gross weight, which could be made available in adequate numbers by 1960. Lockheed had no difficulty in listing the following advantages of the F-104:

- The aircraft began flight testing as long ago as 1954, is in service in substantial numbers and is integrated into a complete weapon system with fully developed ground equipment.
- Of all the types suitable for consideration it has the lowest combat weight and can be varied in take-off weight within a wide margin depending on external loads (e.g., auxiliary tanks to increase range).
- A two-seat version (F-104B) is available for training purposes.
- The F-104's electronic equipment can be adapted for differing main roles, and both air-to-air missiles with infra-red homing (*Sidewinders*) and missiles with radar homing (e. g., *Falcons*) can be carried; finally the aircraft can also be equipped, fuelled and armed to act as a long-range fighter-bomber.
- In particular the F-104 has a system of boundary layer control (blowing) which enables it to take off and land on very short runways. If needed, the zero launch method of take-off can be employed.

and will involve very large turning radii. The most likely tactics would appear to entail firing a highly lethal infra-red missile on a pursuit course before the enemy has a chance to take evasive action or prepare the same fate for one of the friendly aircraft. The F-104's power-boosted controls and automatic pilot enable it to make relatively close turns at all combat altitudes, and its speed margin combined with high acceleration capability permit it to catch up rapidly with an enemy.

6. Fighter-bomber missions against air bases: Another way of driving enemy fighters from the combat zone is to rob them of their bases. The F-104 is well suited to this task, as it can approach the enemy's advanced airfields and launching ramps at supersonic speed, destroy them with highly efficient bombs and return rapidly to its own base.

7. Fighter-bomber missions against the enemy's rear: For attacks on targets far in the enemy's rear the F-104 can be equipped with two or four auxiliary fuel tanks and the most suitable form of external armament. It can fly in at very high altitude. Its depth of penetration has been estimated by military experts at 1,000 miles or more. After completing – or aborting – its mission, it again escapes at supersonic speed.

For the primary roles outlined above the F-104 has been integrated with all the relevant airborne electronic equipment and weapons (see box), and with the ground equipment required to prepare an operation, into a complete *weapon system*. The support equipment has already been described in an earlier issue of *Interavia* (April 1958), but the most important data are recapitulated: 1. an alert

Like this North American F-100, the Lockheed F-104 can also take off from a mobile zero length launcher if required, with the aid of a large solid-propellant booster.

start of a fully prepared F-104, from closing of the canopy and pushing of the starter button to beginning the taxi run, takes 75 seconds; 2. turn-around between two sorties, i. e., replenishment of fuel, lubricants, oxygen, hydraulic fluid, replacement of cannon, ammunition and missiles, insertion of a new brake parachute, etc., within an average of 13 minutes. Like the F-100 (see picture), the F-104 can also if required take off from a mobile ramp by the zero launch procedure, with the aid of a solid-propellant booster. On concrete runways it requires the same, or less, take-off and landing distance as other modern high-performance fighters.

COLLINS SYSTEMS ARE NOW IN PRODUCTION FOR (LEFT TO RIGHT) THE NAVY'S MCDONNELL F4H-1 AND CHANCE VOUGHT F8U-3 FIGHTERS AND NORTH AMERICAN A3J-1 ATTACK BOMBER, AND THE AIR FORCE'S REPUBLIC F-105 FIGHTER-BOMBER.

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. . . The Caribou carries payloads up to $3\frac{1}{2}$ tons — but is unique in its ability to operate from short, improvised air strips.

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. . . Large rear loading door provides access to thousand cubic foot cabin, permits cargo dropping in flight.

. . . As civil transport, accommodates 27 passengers and baggage. As troop transport, 28 combat troops.

. . . Air ambulance takes 14 litters, 6 sit-up patients or attendants.

. . . Structure is conventional, simple, rugged... designed for minimum field maintenance and low operating costs.

. . . STOL ability enables the Caribou to operate from tiny jungle landing strips, from beach-heads or from short fields close into centres of population — ushers in a new era of low-cost air transportation.

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Trained and experienced to
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The Fiat G.91 Strike Fighter

A realistic contribution to European defence

German Defence Minister Strauss inspects the G.91's cockpit.

VIP guest at Fiat: General White, USAF Chief of Staff, visits the Turin aircraft plant, accompanied by Professor G. Gabrielli, head of Fiat's Aviation Division (right), and General Manager G. Perosino.

Before there could be any question of strengthening European defence by the introduction of a standard NATO strike fighter, there were many conflicting technical viewpoints which had to be reconciled among the military experts. And above all, there was the delicate question of financing to be solved.

Here Fiat was able to avail itself of the experience acquired in the licence production of the North American F-86K all-weather fighter and the development of its G.81 and G.82 designs. Three prototypes and 27 pre-production models of the G.91 had been put in hand, thanks to joint Italian and American financing, when NATO decided, in spring 1958, to equip the ground attack squadrons under SHAPE control with the Fiat G.91. But then events moved rapidly.

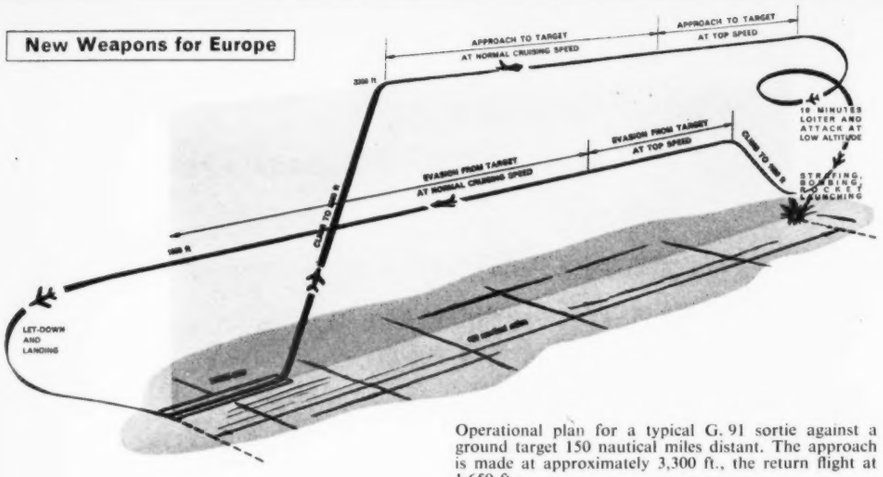
During the summer of the same year an international G.91 squadron was formed from the pre-production models. At present stationed in Italy, this squadron is designed to give European air force pilots an opportunity of undertaking the tactical testing of the new aircraft. Early in 1959 the experimental unit is to be moved to West Germany, where it will take part in the exercises of the Allied Land Forces, Central Europe, as part of a brigade or division. The squadron will include pilots from the German, French, Greek, Italian and Turkish air forces; General Norstad has stated that its strength will be at least 25 aircraft.

Meanwhile the West German and Italian Governments have decided to equip several of their air force units with the G.91. On November 6th, 1958 the German Bundestag's Defence Committee approved the procurement of 50 Fiat strike fighters, enabling the Federal Defence Ministry to finalize the purchase contract with Fiat. At the same time an agreement was concluded providing for the licence production of an additional 150 Fiat G.91s by German manufacturers, probably Dornier and Flugzeugunion-Süd (Heinkel and Messerschmitt). Furthermore the Italian Air Force has placed a firm order for 50 aircraft.

The French Government, which originally planned to order 48 G.91s, recently issued a communiqué stating that the projected procurement of Fiat strike fighters would be impossible in the 1959 budget year "for financial reasons," but apparently Fiat has not yet given up all hope. France's attitude in the G.91 question is unmistakably connected with the NATO decision not to pursue its original plans for a "second generation" strike fighter (Breguet *Taon* or Dassault *Etendard IV*), but rather to "stretch" the G.91 through continuous development until the "third generation" of vertical or short take-off strike fighters is available.

An unexpected development has been that Austria, a non-NATO country, has also been showing interest in the G.91. In fact, the visit of a Fiat team to Vienna some time ago has now been followed by an Austrian order for the first 14 aircraft. Negotiations concerning the delivery of a substantial number of G.91s

Fiat G.91 single-seat strike fighter: beneath the fuselage is the large-area two-part air brake.


APPROACH TO TARGET AT NORMAL CRUISING SPEED
APPROACH TO TARGET AT TOP SPEED
10 MINUTES LOITER AND ATTACK AT LOW ALTITUDE
EVASION FROM TARGET AT NORMAL CRUISING SPEED
EVASION FROM TARGET AT TOP SPEED
LET-DOWN AND LANDING

Operational plan for a typical G. 91 sortie against a ground target 150 nautical miles distant. The approach is made at approximately 3,300 ft., the return flight at 1,650 ft.

Bristol Orpheus and NATO

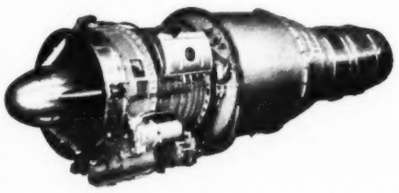
A major part of the success of the NATO lightweight strike fighter programme culminating in the production of the Fiat G.91 has been the common powerplant, the Bristol *Orpheus*. This remarkable engine has had one of the fastest development times of any turbojet thanks to its simplicity and good basic design.

Project studies commenced in November 1953, when the unit was known as the BE-26, and full-scale design began in January 1954 as a private venture to power the Folland *Gnat* fighter.

In March of the same year the NATO lightweight strike fighter specification was issued. While firms were preparing their projects, Bristol went ahead at full speed on their engine. In June, drawings were issued to the shops, and by December 17th, 1954 the first *Orpheus* was actually running on the bench — less than a year after design commenced.

The *Orpheus* was satisfactorily amassing bench hours when, in March 1955, NATO gave official instructions for development of the *Orpheus* to 4,850 lb. thrust prior to placing contracts for the G.91, Breguet *Taon* and Dassault *Etendard VI* prototypes in June.

First flight of the engine took place in a Folland *Gnat* in July, and in December the Bristol-Fiat agreement was signed covering collaboration on *Orpheus* installation in the G.91 and granting Fiat an option to manufacture.



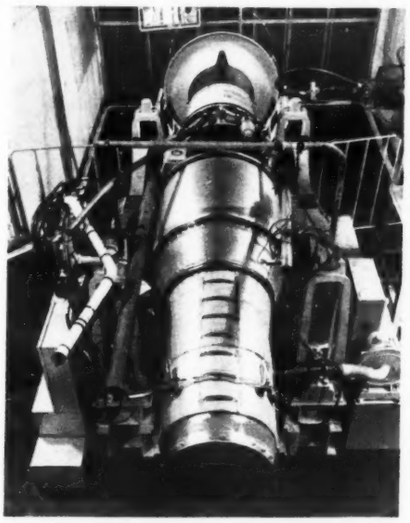
The Bristol Orpheus 803 *jet engine of 5,000 lb. static thrust.*

On August 9th, 1956 when the G.91 made its first flight with the BOr.1 of 4.050 lb. static thrust (type tested in January) Bristol had amassed over 5,000 hours running.

The next development, the BOr.3 of 4,850 lb. static thrust was running by December 1956, and deliveries were made to Italy and France in February 1957 after completion of a special category test. Only three months later the BOr.3 had passed its official 150-hour type test.

In September to October 1957 the Brétigny trials were held, with all the contenders except the *Baroudeur* being equipped with the BOr.3. Following the success of the G.91 in the trials, a manufacturing agreement on the *Orpheus* was signed between Bristol and Fiat in December, and the NATO decision to adopt the G.91 was announced in March 1958.

Development of the engine meanwhile continued apace towards the goal of the BOr.12 with 6,810 lb.



The Bristol Orpheus 801 *jet engine (BOr. 3) after completion of the official 150-hour run with 4,850 lb. thrust.*

Prof. Vittorio Valletta (right), President and Managing Director of Fiat, and Sir Reginald Verdon Smith, Chairman and Managing Director of Bristol Aeroplane Company Ltd., after signing an agreement on licence rights to the Bristol Orpheus *on December 9th, 1957.*

rating (8,170 lb. with reheat), and in July 1958 the *Orpheus 803* first ran, at 5,000 lb. static thrust for a weight of 835 lb. The BOr.12 is now at the bench running stage.

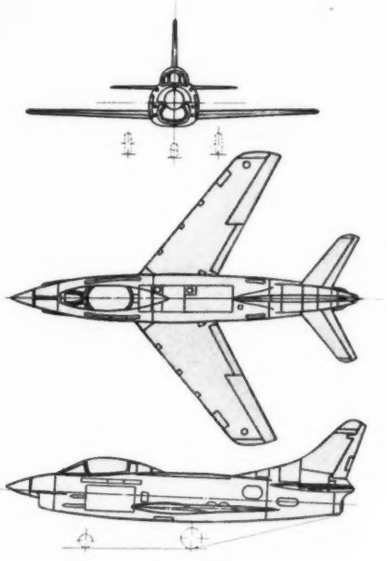
Licences for the *Orpheus* are held by three European countries, Italy, Germany and France. The Fiat agreement is fully comprehensive, with exchanges of engineering teams as well as manufacturing information. In Germany BMW holds the option to build, but it seems unlikely that this firm will finally undertake production; in this connection negotiations are now going on between Bristol and the German Government.

SNECMA holds the *Orpheus* licence in France, but to date there are no details as to when or if production will start, as France has not yet ordered the G.91.

to Greece and Turkey should now be nearing completion, though these two countries appear to be desirous of acquiring their aircraft through the U.S. arms aid programme rather than from their own funds. This would at any rate mean that four NATO countries would be equipped with standard aircraft for tactical support operations in the fighting zone. A Belgian team has also arrived in Turin to flight test the aircraft, which may be the first step towards the formation of G.91 squadrons in the Benelux countries.

This is no mean success for NATO, particularly in view of the multitude of conflicting requirements put forward by the individual air forces as regards performance, armament and other installations. And although technical viewpoints have now been reconciled, there still remains a second group of questions to be solved: will the political, industrial and economic problems likely to be raised by the licence production of the NATO strike fighter be solved on the broadest possible basis? A beginning has already been made, and 1959 may well bring the final answer.

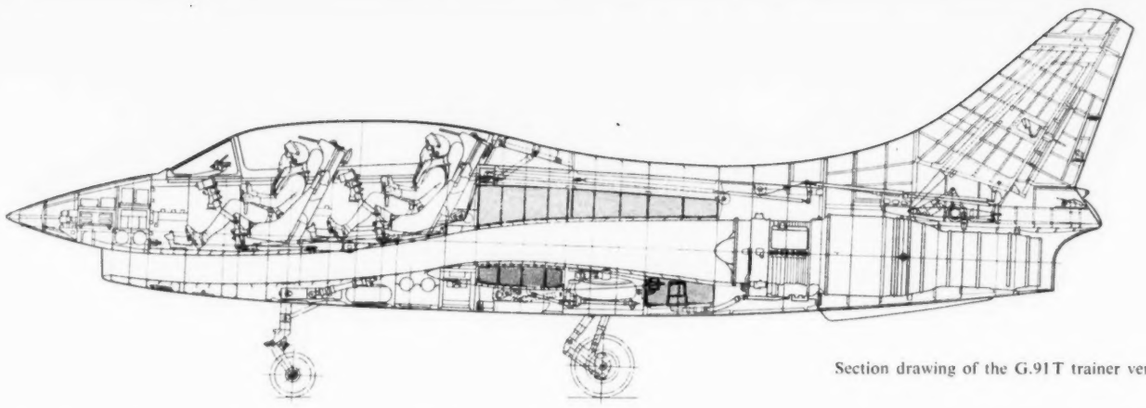
*



Three-view drawing of the Fiat G.91.

There is no need here to discuss in detail the specifications for the new standard light weight fighter, as worked out by SHAPE at Fontainebleau, or recapitulate the G.91's development history; earlier *Interavia* issues have already dealt thoroughly with these subjects (cf. Nos. 1 and 4, 1958). Nevertheless the following brief outline of the reasoning behind the design, together with a summary of recently available data, will serve to situate the project.

The designers' object was to coordinate performance, controllability, take-off and landing qualities, adaptability of equipment and other operational factors in such a way



Section drawing of the G.91T trainer version.

that *all* required missions could be performed to full satisfaction. Without this need to compromise it might perhaps have been possible to improve one or other of the aircrafts's qualities (at the expense of the others), but then the aircraft would no longer have met NATO specifications. The important factor was the powerplant, which, with its power-to-weight ratio of 6, permits the carriage of a military load (armament plus fuel) roughly equivalent to 50 percent of the aircraft's gross weight. Another important point is the short-legged undercarriage with low-pressure tyres (main wheels 50 p.s.i., nose wheel 43 p.s.i.), which enables the 11,460-lb. aircraft to take off from grass runways only 900 yards long. A landing gear with high-pressure tyres of 128 to 199 p.s.i. could have been designed to be lighter and less bulky for the same gross weight, but only by prejudicing the aircraft's ability to operate from cheap, rapidly prepared runways.

Interchangeable armament combinations—0.5-inch, 20-mm or 30-mm guns, rockets, H.E. or napalm bombs—make the G.91 a versatile combat aircraft. The mobility of a G.91 unit is greatly increased by the fact that all auxiliary equipment can be loaded on trucks. Yet another vital point is the time required for ground handling, i.e., refuelling and rearming a G.91, which can be accomplished by 4 to 5 men in less than 10 minutes, thanks to good accessibility and the ease with which the guns can be replaced. This means that several missions, even of differing characters, can be carried out in relatively quick succession.

*

One more word on the question of costs. As the original NATO specification called for a relatively small, easily produced light strike fighter with a minimum of airborne equipment, any further drastic reduction in production costs per aircraft could be obtained only by building in large numbers. After all, as Fiat Aviation Division Manager Professor G. Gabrielli pointed out in 1957, the Russians have long adopted this method, restricting themselves to large-scale production of a few carefully chosen types. "Today," continued Professor Gabrielli, "it is absurd to think of producing an aircraft of the light attack type in series of less than 1,000 units."

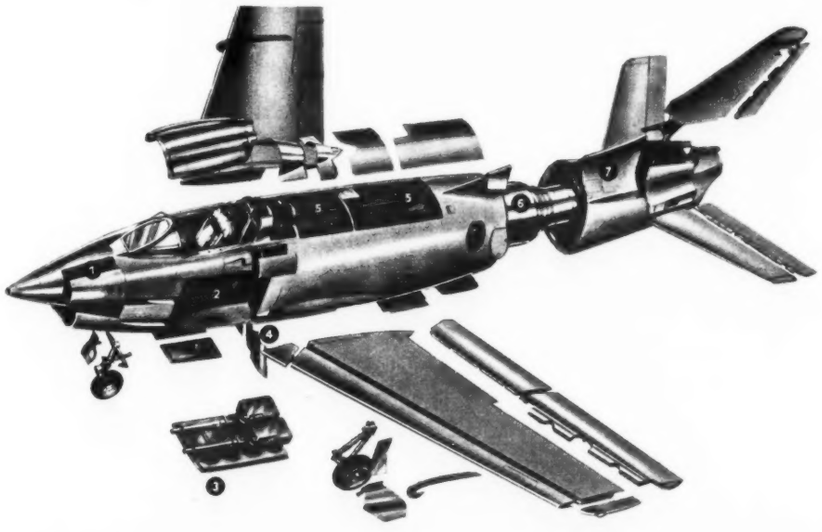
This is the argument behind Fiat's efforts to develop the basic G.91 model into a number of variants to complement or later take over the original aircraft's duties. The G.91T two-seat trainer version, with longer fuselage and Bristol *Orpheus 803* turbojet (5,000 lb. static thrust), and a G.91R reconnaissance version were announced as early as 1957. A relatively small number of trainers has already been ordered by the Italian Air Force. The G.91R reconnaissance aircraft has the same performance as the standard model, and retains its take-off and landing qualities. The only modifications are to the fuselage nose, to accommodate the camera equipment. In addition Fiat is working on an improved "S" version of the G.91 with the more powerful *Orpheus BOr.12* of 6,800 lb. take-off thrust without reheat. The increased thrust will not only result in improved performance by comparison with the present G.91 version, but will also shorten the take-off distance still further or enable still higher loads to be carried.

The Fiat G.91 is not a miracle design, but rather what might be termed an "honest-to-goodness" aircraft. Perhaps this is all in its favour. Fiat is counting on a long life for its strike fighter . . . and the production lines at Turin are dimensioned for manufacture in large quantity.

Technical Data for the G.91 Series

Type Designation	G.91	G.91T	G.91S
Powerplant	Bristol *Orpheus 803*	Bristol *Orpheus 803*	Bristol *Orpheus 12*
Max. static thrust (lb.)	5,000	5,000	6,800
Span (ft.)	28.24	28.24	—
Wing area (sq. ft.)	176.7	176.7	ca. 195
Sweep at 25%+ chord	37°	37°	37°
Aspect ratio	4.48	4.48	—
Thickness/chord ratio	10%	10%	—
Normal take-off weight (lb.)	10,360	—	—
Max. take-off weight (lb.)	11,460	11,250	ca. 13,200
Weight empty (lb.)	ca. 6,600	7,050	—
Payload (lb.)	ca. 4,850	4,200	—
Max. wing loading (lb./sq. ft.)	65	64	—
Max. power loading (lb./lb. t)	2.29	2.25	—
Max. level speed (knots)	ca. 580	570	ca. 600
Max. Mach number	ca. 1.1	1.06	—
Penetration depth (nm)	ca. 150	570 (range)	200—250
Take-off distance to clear 50 ft.	2,700	2,700	—

Complete sub-assemblies can be rapidly replaced and are designed to ensure ease of maintenance. 1. radio and navigation equipment; 2. weapons bay; 3. rapidly removed weapons platform; 4. air brakes; 5. fuel tanks; 6. jet engine; 7. removable fuselage rear to provide access to the engine.



First European Surface-to-Air Missile in Operation

—Bristol/Ferranti Bloodhound

In December 1958 Britain organized a classified exhibition of guided missiles in Paris to demonstrate her readiness to join in a coordinated European system of arms planning. The following is a description of one of these weapon systems, which merits consideration as a contribution to continental European defence: the Bristol/Ferranti Bloodhound.

A *Bloodhound* surface-to-air missile at operational readiness on its launcher.

The *Bloodhound's* first development phase can now be considered as completed: the weapon has already gone into production, has been accepted by the Royal Air Force as an integral part of its new air defence system and is now undergoing operational trials. The Swedish Air Force, too, has ordered an undisclosed number of *Bloodhound* missiles, together with the related control and ground support equipment.

*

The first British *Bloodhound* base was organized, without publicity, at RAF Station North Coates last year, and it is already some months since operational trials began on the Bristol/Ferranti weapon, which is now being progressively incorporated into the British air defence system with the object of ensuring protection for point targets. North Coates is described as a model for future SAGW (Surface-to-Air Guided Weapon) bases. At the same time the installations are used for test and training purposes, and the station houses not only the Operations Wing, which is kept at constant readiness, but also an extensive Trials and Testing Wing.

The *Bloodhound* unit stationed at North Coates is similar in structure to an RAF fighter wing. It comprises three fire units comparable to fighter squadrons, and each fire unit is divided into flights, each in turn with several missiles. The flight has its own target illuminating radar and launch control post. In addition to the three batteries (flights), the tactical control radar and the control centre on the edge of the airfield, the North Coates station includes missile stores, assembly and servicing areas, repair shops, a static test bed, communications systems, a power supply system and the headquarters and installations of the trials and testing wing.

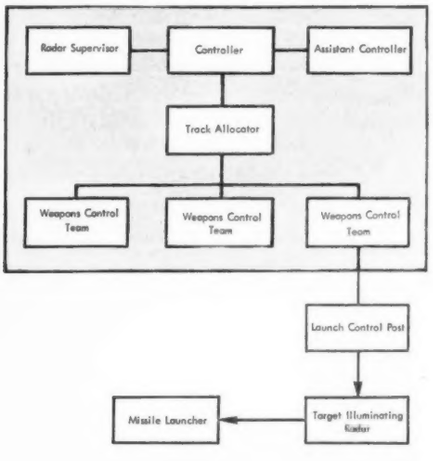
The organization and method of operating of a *Bloodhound* unit are illustrated by the accompanying drawings.

Once the early warning radar system has detected enemy raiders and the *Bloodhound* wing has been allocated one or more targets, a three-dimensional tactical control radar attached to the wing tracks the targets' movements. All the radar data are immediately evaluated and electronically stored in the control centre. The latter is commanded by the controller, who works in front of two radar screens; one reproduces the image from the early warning radar, transmitted by television link; the other (lower screen) shows data from his own tactical control radar. He is seconded by an assistant controller, who is responsible for carrying out operational orders and maintaining communications, and by a radar supervisor, who controls all the radar equipment attached to the wing. With the aid of a small joystick the controller moves an optical marker ring until it encloses the target echo, thus concentrating the automatic defence system on this target. The latter is then passed to the track allocator, who also places his marking ring around the selected target, with the aid of a similar joystick, tracks the target for a certain time, gives it an identification (figures and letters) and finally feeds the target data into the electronic storage system. At the same time details of the targets and their identification numbers are presented on the large "tote board".

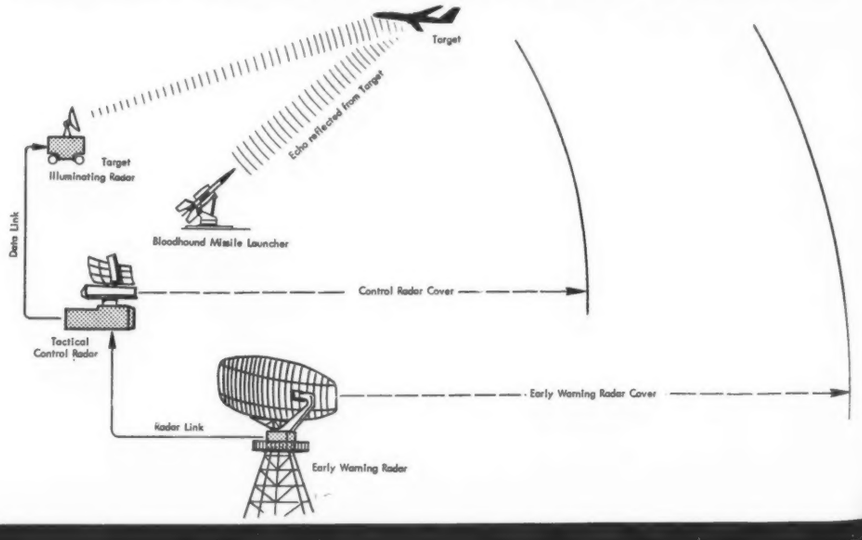
The information collected by the data storage system is passed to the weapons control teams, who are from then on responsible for tracking and destroying the targets. These teams each have a radar screen arranged on a gallery in front of the tote board in such a way that the latter can be watched from each screen position. Each individual team comprises a target selection officer, two target trackers and a height operator. The target selection officer appoints one of the two target trackers to watch the enemy, while the height operator adds the target height obtained from the tactical control radar. The TSO must then decide when the target shall be engaged and by which of the *Bloodhound* missiles under his control. Once he has actuated a switch on his desk, the target illuminating radar of the selected battery swings into the direction of the target, locks on and tracks it in its pencil beam, whereupon the word "ENGAGED" appears above the particular target on the tote board. The selected missile launchers follow the radar in azimuth.

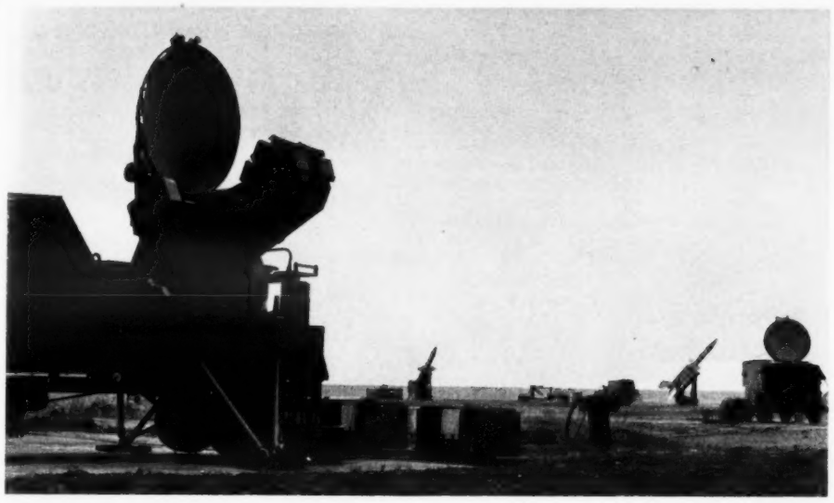
The target selection officer can now give the order to fire a given *Bloodhound* . . . or to break off the whole operation. Meanwhile the automatic pre-launch checks of the *Bloodhound* missiles are taking place in the launch control posts. Results of these checks are indicated by a sequence of lights. When the lights register total readiness for flight, the launch control operator presses the firing button, and four solid-propellant rocket boosters accelerate the *Bloodhound* to supersonic speed. On burnout these are jettisoned, and the *Thor* type ramjets—which burn kerosene and use

Organizational diagram of the *Bloodhound* control centre at North Coates.



Operational diagram of the Bristol/Ferranti *Bloodhound* surface-to-air missile, with semi-active radar homing.





At the North Coates *Bloodhound* base: in the foreground, left, is a British Thomson-Houston target illuminating radar.

Antenna array for the Metropolitan-Vickers tactical control radar.

the ram effect for compression—take over completely as power units.*

The receiver inside the *Bloodhound* incorporates a gyro-stabilized antenna system which picks up the target reflections, thus observing the line of sight to the target. By a system of proportional navigation in three dimensions, the homing equipment computes the course for interception. The energy re-radiated from the target is converted through a series of servo motors to operate the flying controls and keep the missile on course for collision. The advantage of the semi-active homing system of guidance, as installed in the *Bloodhound,* is that it gives greater range accuracy than conventional beam-riding systems; it is also simpler and more economical than an active homing system.

The target illuminating radar, known as Sting Ray and built by British Thomson-Houston, works on a variable pulse repetition rate and frequency, to guard against counter-measures. The *Bloodhound's* receiver is tuned to the radar of its own battery and will not accept guidance instructions from any other source.

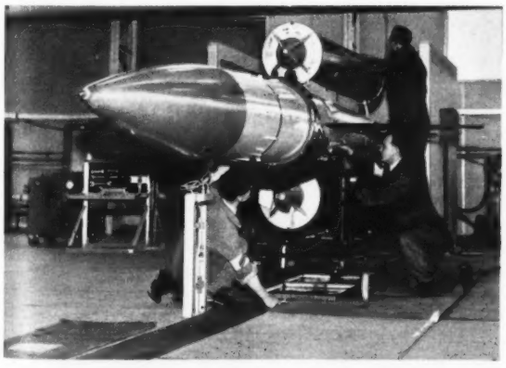
No actual weapons are fired at North Coates in peacetime, but full-scale launching tests are scheduled to take place at the Aberporth range in Wales, and joint Ministry of Supply/RAF acceptance firing trials are in progress at Woomera, Australia.

The operations wing at North Coates has the same status as the traditional fighter wing, to which it forms a complement; other *Bloodhound* units are to be set up shortly.

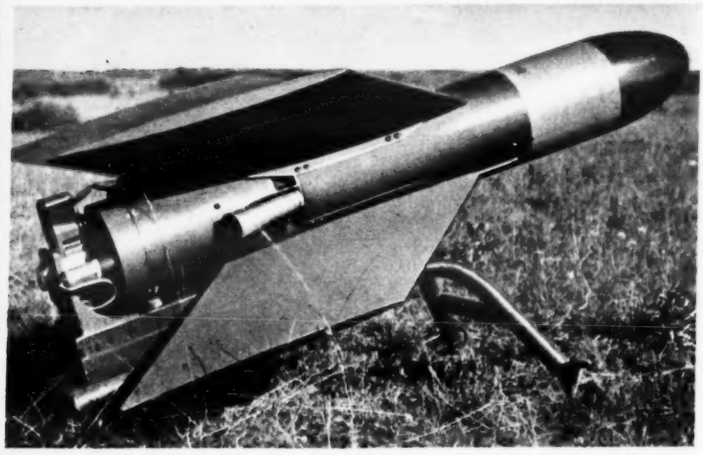
* Cf. *Interavia* No. 11, 1958, p. 1185.

Preparing an operation at North Coates: a *Bloodhound* missile has been transported on its trailer from the test station to the launcher on the field, slid on to the launcher (above), connected to the automatic launch system and placed in firing position (below).

After completion of functional checks on the static test stand in the hangar...



. . . a travelling crane raises the missile on to its trailer, which is then towed by jeep to the launcher.



Nord SS. 11 anti-tank missile.

Among the weapon systems developed in France since the war, it is above all the Nord Aviation SS.10 and SS.11 anti-tank rockets which have won a place for themselves on the international market. Not only have the French armed forces been equipped with the Nord wire-controlled missiles, but they have also been accepted in Germany, Britain, Israel, Italy, Norway, Sweden and the United States. Norway has bought a small number of SS.11s and is studying them with a view to producing them under licence. Sweden has placed a substantial order for SS.10s with Nord Aviation, and Italy is reported to be considering the purchase of around a thousand SS.10s and SS.11s for trial and training purposes. Of late there have been negotiations with American manufacturers, a development of particular interest in view of the cancellation of contracts for the American Dart *anti-tank weapon. As far back as 1957 the United States received considerable deliveries of French anti-tank missiles, including no fewer than 1,166 SS.10s, some of which went to the 7th U.S. Army in Germany. The following report has been compiled on the basis of information and photographs supplied by the manufacturers.*

Editors

The Multiple Applications of the Nord SS.11 Weapon System

A jeep with a two-man crew, dragging a trailer behind it, stumbles along a narrow field path and halts behind a bush, out of sight of the enemy. The gunner next to the driver turns round to face rearwards. Facing him now are four black boxes with electronic equipment mounted on the inside of a sheet steel screen. Behind this screen, on small mounts, are three winged missiles, which are instantly erected when the gunner operates a small crank. A lever is thrown and a button pushed; then there is a whistling sound, barely audible a hundred yards away.

It is only a few seconds since the jeep took cover behind the bush, but a wire-controlled SS.11 anti-tank missile is speeding towards the target, at more than 330 ft./sec. A small joystick the size of a fountain pen enables the gunner to guide his missile only a few feet above the ground, past all intervening obstructions, inexorably to the enemy tank emerging from behind rising ground a mile or two away. The gunner's job could not be simpler: all he has to do is to keep the green flame from the SS.11 superimposed on the target in his telescopic sight. Even rapid movements by the tank cannot take it outside the telescope's field of view at the combat distances indicated.

The crew of the tank is knocked out without having seen or heard a thing. One second before impact the missile was still some 200 yards away from the tank and was visible only as an object of roughly 16 sq. ins. frontal area. And even if the tank crew had seen the SS.11, it could not have taken evasive action in only one second. Moreover, a wire-controlled missile cannot be jammed by radio counter-measures. And even the heaviest armour plating up to 600 mm (2.4 ins.) thick can be neatly pierced by the SS.11's hollow charge. Even if the hollow charge strikes the armour plate at an angle of 30°, it can still penetrate to a depth of 600 mm, so that in this case plates up to 300 mm in thickness are cut through.

As soon as the first tank has been placed *hors de combat* the gunner switches his controls to a second missile and pushes the launching button. As the jeep plus trailer can carry a total of nine missiles, and each launching, including guidance as far as the target, takes at most 20 seconds, at least seven enemy tanks can be destroyed within four minutes of the jeep's going into position—hit probability is roughly 80 percent.

If the requirement is to operate against tanks at shorter range—say, less than 1,500 yards—the jeep would be equipped with the lighter Nord SS.10 missiles, which are controlled in the same way, via wires.

*

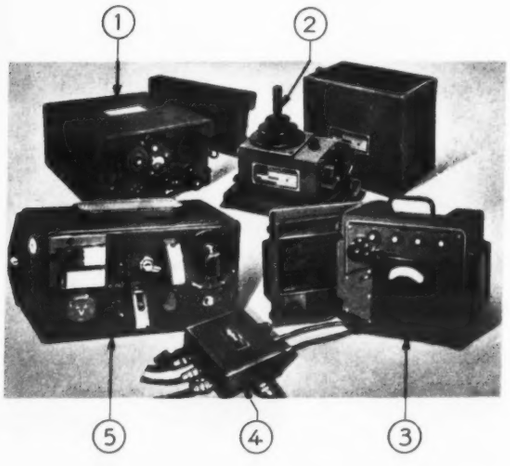
The launching of SS.10 or SS.11 missiles from a jeep is only one of the possible methods by which they can be used. Infantry or airborne units can employ them without vehicles, in which case their transport cases contain either the standard launching mount or a folding support for launching direct from the ground. Up to six missiles can then be controlled from a single guidance post. Moreover, the latter can be set up more than 100 yards away from the rockets, at a point giving a good view of the enemy. A battery of this kind can cover an area within an angle of 60°, as the gunner can direct his missiles, after launching, to any point within this area.

In other applications the hollow charge (for anti-tank use) can be replaced by an anti-personnel warhead for use against troops. As the high degree of accuracy is retained in this application (hit probability against a target measuring 2 yards square at average range is roughly 85 to 90 percent), the SS.11 is well suited for use against nests of resistance in guerilla warfare, which can be destroyed without unnecessary damage to surrounding buildings or the civil population. Finally, the navy also has good uses for the SS.11, for coastal defence, protection of landing barges, or armament of light vessels. The naval version of the SS.11 is supplied with control wires specially resistant to sea water.

All the weapon types in this series are derived from the same basic design and require the same control equipment. All feature simple and rugged structure and can be dropped by parachute in the standard transport container, complete with control equipment. Before delivery the rockets are subjected to stringent tests (shock and vibration tests, submersion in water, artificial rain, temperature shocks from +50° to −30°C), which practically all units pass with flying colours. That the SS.10 and SS.11 are already included in the arsenals of so many countries is telling proof that these Nord Aviation weapons have reached operational status.

Comparative data for SS. 10 and SS. 11

Type Designation	SS.10 (Type5202/5203)	SS.11 (Type 5210)
Powerplant	two-stage solid-propellant engine	two-stage solid-propellant engine
First stage burning time	—	1.4 sec
First stage burnout speed	—	330 ft./sec
Second stage burning time	—	22 sec
Second stage burnout speed	330+ ft./sec	625 ft./sec
Length	33.8 in.	46 in.
Wing span	29.5 in.	19.7 in.
Gross weight	33 lb.	63 lb.
Weight including transport container	88 lb.	141 lb.
Minimum operating range	550 yd.	550 yd.
Maximum operating range	1,750 yd.	3,850 yd.

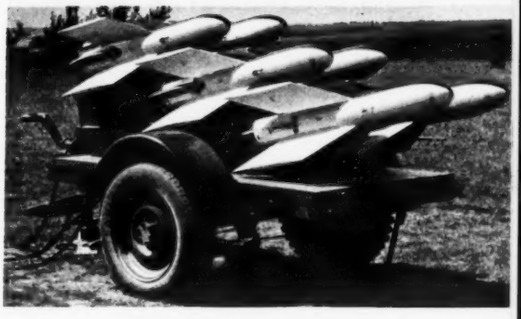


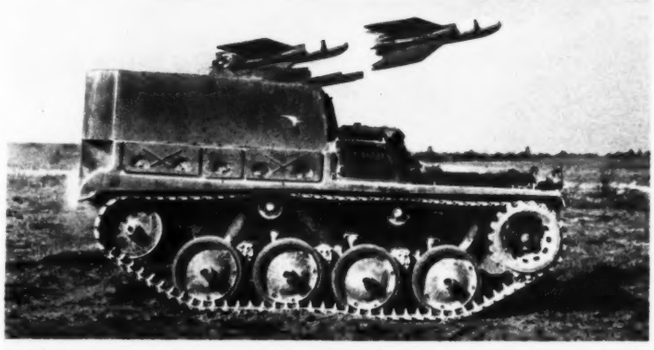
Auxiliary equipment for the SS.11:

1.	T.9 generator	weight 29.5 lb.
2.	Joystick with signal emitter	,, 12 lb.
3.	Fire control test equipment	,, 15.2 lb.
4.	Distributor box to individual missiles	,, 10.5 lb.
5.	Control equipment, Type 5	,, 6.6 lb.
	Total weight	73.8 lb.

The earlier SS.10 for anti-tank operations over shorter ranges.

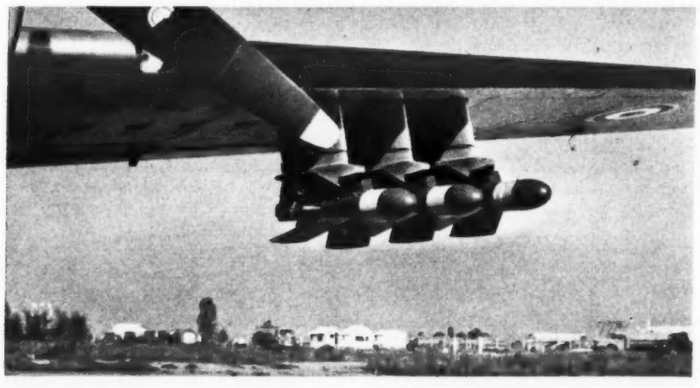
Mobile employment of the SS.10 or SS.11 from a jeep: at the rear of the vehicle are three missiles on short mounts (upper left). On the inner side of the sheet steel screen are the four main elements of the auxiliary equipment (lower left), which can be operated with the minimum of attention even in the heat of battle. During the actual firing of the missile the jeep driver and gunner duck down behind the screen (upper right). Within fractions of a second after launching the missile is fully controllable; the gunner rises and follows its flight through his telescopic sight. When the three SS.10s on the jeep have been launched, the remaining six on the trailer (lower right) are also fired.

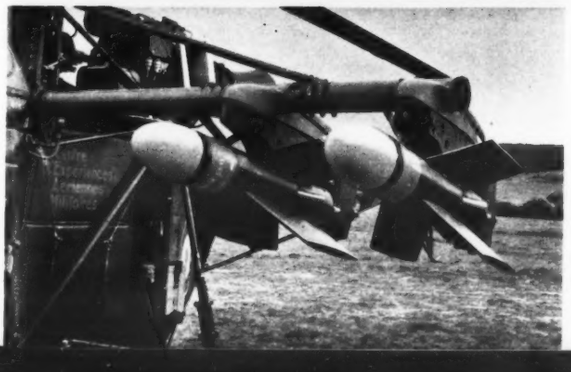




A Hotchkiss self-propelled mount firing a Nord SS.11. Four of these weapons can be carried on special launchers on top of the armoured crew compartment.

The French AMX 13 armoured vehicle has also been tried out as carrier for the SS.11. Its gun turret can be swivelled within certain limits in both the horizontal and the vertical plane, so that the missile can from the outset be launched in the desired direction.





Helicopters such as the *Alouette II* shown on the left can carry several SS.11s on booms and pop up suddenly from behind natural obstacles to attack tanks, vehicles or fortifications from low altitude. The launcher used for airborne operations differs from the standard launcher, but the remaining auxiliary equipment is similar. Fixed-wing aircraft with speeds of less than 275 m.p.h. (righthand picture) can also be used as carriers for the SS.11, using the highly accurate weapon as a guided bomb with special warhead.

The Amphibious Helicopter

By Norman C. Taylor, Chief Engineer, Vertol Aircraft Corporation, Morton, Pa.

One of the most significant contributions to improved utility of the helicopter in military and commercial operations is the development of permanent flotation equipment which overcomes limitations of earlier systems without seriously penalizing overall aircraft performance.

Vertol Aircraft Corporation's success in this area is effectively demonstrated by its amphibious *Vertol 44* (commercial version of the improved H-21), a helicopter certified by the Civil Aeronautics Administration for day and night auto-rotation landings in sea state 3 *. The amphibious conversion of the 44 adds only 319 lbs. to the weight empty, adds little drag and does not require a hull-shape fuselage modification.

New York Airways, the world's first scheduled passenger helicopter airline, and the Swedish Navy are now operating Vertol 44s equipped with the new flotation gear.

*

In its design approach to flotation equipment, Vertol established the following desirable qualifications for an ideal amphibious helicopter: 1. Light weight. 2. Permanently inflated floats. 3. Both lateral and longitudinal stability sufficient for sea state 3 and to meet stability requirements of U.S. Navy Spec SR-59c. 4. Minimum aerodynamic drag and download. 5. No increase in vibration level. 6. Ability to make day or night auto-rotation landings under marginal visibility without precise determination of altitude before contact with water. 7. Strength for landing at high vertical and horizontal contact velocities. 8. Large rotor clearance with the water to permit nose-high or level auto-rotative landings. 9. Minimum change to the land plane configuration. 10. Ability to start and stop rotors on water with no yawing tendencies. 11. Good water handling characteristics.

It became quickly apparent that a large number of the design objectives for an amphibious helicopter would be satisfied by waterproofing the fuselage to support a large part of the gross weight in the water, rather than by keeping the fuselage high and dry. The static water line on the fuselage was located just below the powerplant installation, eliminating any need to modify this important section of the helicopter.

A total buoyancy from fuselage and floats of 150 percent of gross weight is available with the Vertol 44. The fuselage supports slightly less than half of the gross weight of the aircraft. The auxiliary floats can support the entire aircraft in the event the fuselage becomes filled with water.

The shape of the Vertol 44's floats and their best angular setting on the landing gear were determined during extensive wind tunnel tests. By developing the most efficient aerodynamic shape of the floats, it was possible to arrive at a design in which the increase in drag was no more than that of the older doughnut floats in a deflated condition.

* i.e., 3 to 5 foot waves. — Ed.

The main float is mounted on the axle of the standard landing gear without any modification. A metal cage supporting the main bag is attached to the oleo to absorb pitching and drag loads, and its small volume does not justify its being made waterproof. The fabric used in the bag is single-ply neoprene-coated nylon with a weight of 13 ounces per square yard and a strength of 250 pounds per inch of width. Hypalon paint is used to retard aging.

The flotation portion of the nose float is a sausage bent into horseshoe shape and wrapped around the nose gear oleo. It is then attached to the fuselage by a fabric fairing. Long zippers are installed on the fairing for easy removal of the float and for easy access to service panels. Both the nose and main bags are inflated to a pressure of 1.5 p.s.i. and each has a pressure relief valve set at 2.8 p.s.i. The bags have a burst strength of 4.5 p.s.i.

Vertol 44 floats are divided into several compartments to provide adequate stability and flotation in the event of loss of pressure in any one compartment. The forward float has five compartments and each aft float has three compartments.

On new fuselages sealing tapes and compounds are inserted at all surfaces in affected areas. On completed fuselages not waterproofed in manufacturing, Vertol has developed a flexible neoprene coating system which has given excellent service. One helicopter with this system has made more than 800 auto-rotative landings with no effect on the coating. A hingeable step is installed at the main cabin door to act as a water dam.

Operational experience has shown that the installation of floats does not affect the ground handling characteristics of the landplane version of the Vertol 44. The main floats do not interfere with entrance into the main cabin door, and standard tow bars can be attached to the nose gear.

This installation adds only 2.2 percent to the gross weight of the helicopter, which is about two-thirds of the weight of the old type doughnut floats. The total installation adds only 319 pounds to the weight of the aircraft.

The amphibious Vertol 44 has excellent water handling characteristics. Taxiing is simple, and 360-degree turns on the spot are easily made even in adverse winds. Complete rotor starts and stops can be made without any tendency of the helicopter to yaw or roll.

In addition, the Vertol 44 exceeds requirements of Navy Spec SR-59c for roll stability in the water, which is a net righting moment of 21,000 ft.-lb. The maximum net righting moment provided by the helicopter is a roll angle of 18 degrees. The 44 also exceeds the CAA requirements for lateral stability of seaplanes. It has a ratio of righting moment to upsetting moment of 3.57, compared with the CAA's ratio of 1.5.

In determining the water loads of the Vertol 44, a typical fuselage section of the helicopter was drop tested to determine its strength and the amount of reinforcement needed to meet high water loads. High speed movies, pressure pick-ups and strain gages were used during these tests to record all pertinent data. It was concluded that the Vertol 44 could take water loads in excess of that required by the Navy and the CAA, by adding only one pound of frame as reinforcement.

During the CAA testing, the aircraft was instrumented to determine load factors, fuselage pressures, landing gear stresses, stick positions and rotor r.p.m. Motion pictures were taken from several shore points to determine aircraft speeds and fuselage attitude at contact. Records were obtained during 100 auto-rotative landings both night and day.

From these data, it was determined that landings had been made at speeds up to 36 knots forward speed and 19 ft./sec sinking speed. The "g's" experienced during water landings were moderate even at high sinking speeds.

The large clearance between the water and the rotor on the Vertol 44 tandem helicopter permits the pilot to land within a wide range of longitudinal attitudes in auto-rotation landings. A study of the records of 100 auto-rotative landings made during the training of pilots of New York Airways, which operates a fleet of Vertol 44s, indicates that landings have been made from the longitudinal attitude of 10 degrees to 30 degrees nose up. This is a variation of 20 degrees in position on water contact. Actually, the design provides for considerably more variation. This means that day and night auto-rotative landings can be accomplished easily by even inexperienced pilots.

Instrumentation records made during 711 auto-rotative landings demonstrate the ease with which the helicopter can be flown and its low load factors during high contact velocity landings.

A typical record made by a student pilot in a night auto-rotation landing, during which stick positions, accelerations, rotor r.p.m. and altitude for 11 seconds before contact were noted, revealed that smooth, coordinated control motions were all that was required. It was apparent that no last-minute, abrupt control motions were made just prior to contact with the water.

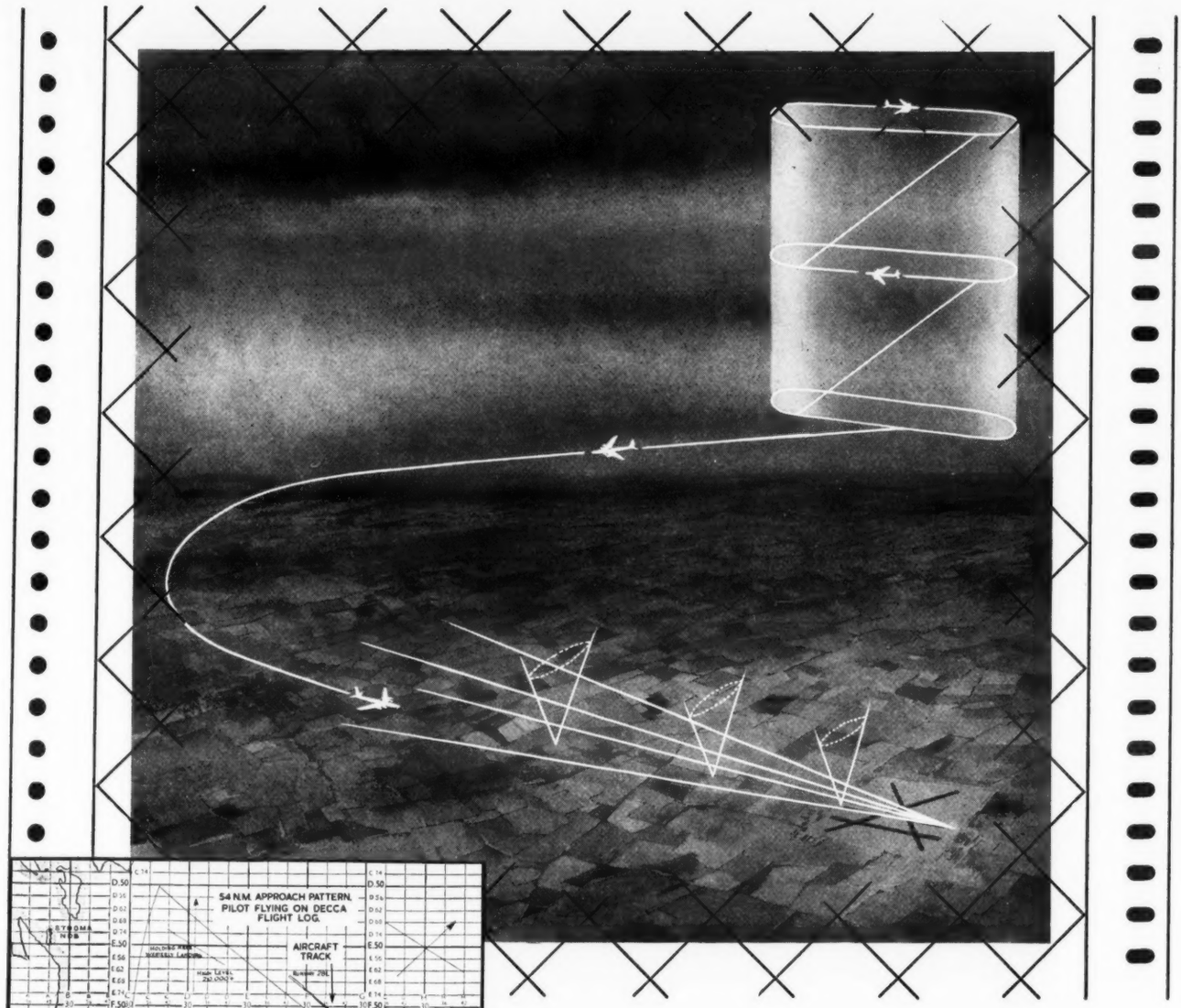
The pilot reduced the vertical descent to 13 ft./sec, a much higher sinking speed than is permissible on land, and then "flew" the helicopter into the water, since he probably did not know his precise altitude above the water. Maximum acceleration developed was only 1.5 g, but on land it would have been in excess of 4 g.

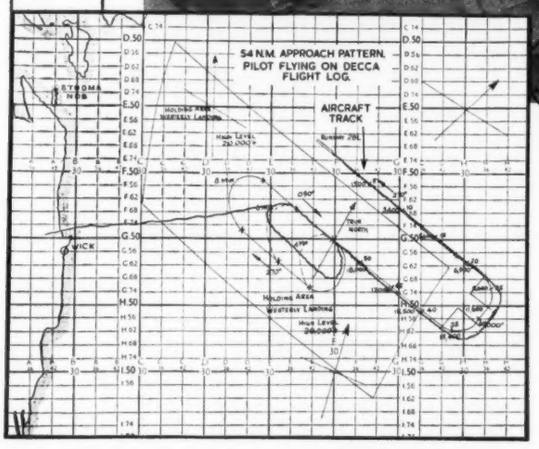
*

The tandem configuration of the Vertol 44, its ability to land under high contact velocities and over a wide range of longitudinal trim positions, permits the pilot to make a safe and low acceleration landing without judging precisely his height above the water.

The Vertol 44 amphibious helicopter taxying in the water at 8 knots on its new flotation gear. It is certificated for autorotation alightings in sea state 3 (3 to 5 foot waves).

The same helicopter making a power-on alighting at about 10 knots forward speed. Angle of incidence of the forward fuselage base is here roughly 25 degrees; an angle of 10 to 30 degrees is permissible.





In the trials, held off the Orkneys, the holding area and runway were simulated exactly as for London Airport. In the above chart, used during the trials, the holding area with 4, 6 and 8 minute orbits is clearly shown together with the required track to the runway also clearly marked with altitude checks down to the threshold. With the Flight Log the pilot was able to navigate precisely at every stage of the flight, greatly simplifying the entire holding and approach procedure.

Decca in the *Jet Age*

Recent air traffic control trials carried out by the Ministry of Transport and Civil Aviation in a D.H. Comet have proved that, with the Decca Navigator Flight Log, jet aircraft can be navigated accurately regardless of altitude or weather conditions.

No other aid is either suitable or accurate enough for holding at altitude within a defined area. With Decca, such areas can be designated independently of ground facilities and flown exactly regardless of drift. Exhaustive tests showed that, with the Flight Log, pilots were able to leave a holding area with a very high degree of precision, track can be maintained precisely during the descent from the holding area to touch down, giving the pilot a continuous check of altitude against distance from touch down.

Knowing exactly where he is at all times by reference to his pictorial display, the pilot has an independent check on radar control, and being able to navigate himself accurately in the terminal area his R/T communication with such control is greatly reduced. The safety of all aircraft is increased by the consequent lightening of the load on the Radar controller. Improved accuracy in time and position keeping, results in the reduction of delays enabling the maximum landing rate to be achieved.

THE DECCA NAVIGATOR

THE WORLD'S MOST ACCURATE NAVIGATOR SYSTEM

THE DECCA NAVIGATOR COMPANY LIMITED LONDON

BRITANNIAS are flying over 80,000 miles daily on the world's trunk routes—cutting previous scheduled times by an average 20%, setting new standards of comfort.

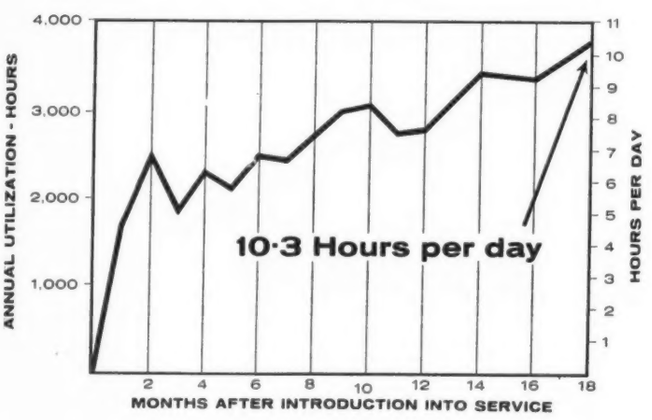
BRITANNIAS have now been operating for two years on some of the world's most exacting routes — in extreme climates — from diverse runways — on stages ranging from short inter-city hops to the longest transpolar flights.

How have they rewarded

Facts and figures of the operators themselves—these provide the conclusive evidence. They bear witness to the soundness of the basic Britannia concept. They prove the Britannia in airline service to be exceptionally reliable, capable of attracting new traffic, and immensely flexible. In a word—profitable.

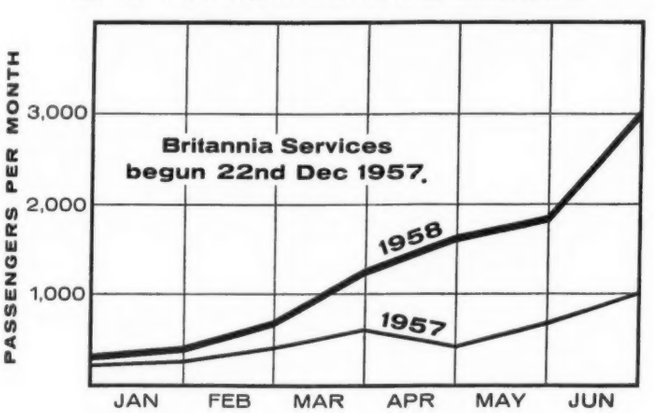
1 Reliable. Britannia's Proteus engines have established an all-time record, since life between overhauls on the turboprop 705 has been raised by the Air Registration Board to 1,600 hours after only 18 months service—a rate never before achieved by any engine, piston or gas turbine. "Engines virtually trouble-free" —*El Al.* "New standard of mechanical reliability . . . nearest approach to ideal propulsion unit for transport aircraft"—*Aeronaves.*

2 Steadily rising utilisation rate. Here again aircraft reliability tells. After a year in service with BOAC, Britannia 100 series were achieving 8 hours per aircraft per day and are now flying more than 10 hours—3,780 hours per annum. After eight months in service with El Al, Britannias were already achieving 8.4 hours per day.



3 Attracting new traffic. On transatlantic routes this year Britannia operators have achieved some of the highest load-factors ever recorded—despite a substantial drop for all carriers. During the first 6 months, BOAC's Britannias were 80.2% full.

EL AL TRANSATLANTIC PASSENGERS



Since introducing Britannias, El Al have trebled their share of transatlantic traffic, while Canadian Pacific on their transpolar Vancouver-Amsterdam route gained a 32% increase in westbound traffic over the same period last year.

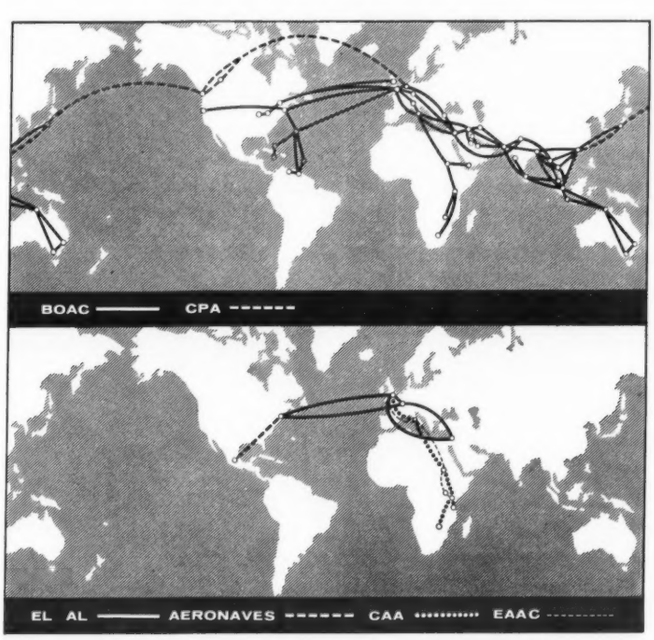
On Commonwealth routes, Britannias have flown 420 million seat miles, 296 million passenger miles—a load-factor of 70%.

THE OPERATORS?

4 Flexible. Britannias fly on stage lengths varying from 300 to 5,000 miles. Routes include: with BOAC, London-New York-San Francisco, London-Montreal-Chicago-Detroit, London-Bermuda-Caracas, on African routes to Johannesburg, and on the Far East routes to Tokyo, Sydney, Melbourne; with El Al Israel Airlines, Tel Aviv-New York, calling at Paris, London; with Aeronaves de Mexico, Mexico City-New York; and with Canadian Pacific Transpolar, Vancouver-Amsterdam, and Trans-Pacific, Vancouver-Tokyo-Hong Kong. Britannias also fly on many other routes for the various airlines.

5 Non-stop transatlantic regularity. During the first six months of this year El Al scheduled and made 183 trans-atlantic crossings. Only once did extra severe headwinds force an intermediate stop.

This 100% regularity continued when El Al were operating as many as five return services a week between Tel Aviv and New York *with only three aircraft*. El Al have recently taken delivery of a fourth Britannia; services are to be still further increased.



All these factors add up to—
PROFITABILITY

Sum total of success in all these factors is contained in one word: profitability.

El Al's experience bears this out. Their Britannias are operating at a ton/mile cost—approximately 20% less than any previously experienced.

BRISTOL
Britannia

BRISTOL AIRCRAFT LIMITED

SAS chose the 'Air Partner'

Scandinavian Airlines System will use 10 Atlas Copco 'Air Partner' compressors to service their fleet of DC-8 jet airliners

STARTING · AIR CONDITIONING · DE-ICING

The Air Partner is a surge-free rotary screw compressor of the Lysholm type designed for starting, air conditioning and de-icing all jet and turbo-prop airliners having air turbine starters.

A SUCCESSFUL COMBINATION

Atlas Copco, the world's largest organisation devoted exclusively to the manufacture of compressed air equipment, combined aeronautical expertise with compressor know-how to produce this multi-purpose unit.

STARTING

The Air Partner delivers a continuous flow of warm, oil-free air to turn the engine over constantly thus eliminating mis-starts.

AIR CONDITIONING

The Air Partner becomes an air conditioning unit by merely flicking the appropriate switches and pressing a button, a matter of seconds.

DE-ICING

A special mouthpiece attached to the air hose enables the wings and fuselage to be 'sprayed' with warm air. Removal of ice and sleet from windshields, wing leading edges, and air intake lips is achieved by using the ordinary de-icing outlets of the aircraft.

SIMPLE MAINTENANCE

The Air Partner has no wearing parts. It consists of two screw rotors which intermesh but never touch one another or the casing. 10,000 hours is the normal period between overhauls for screw compressors of this type.

Maintenance operations can be carried out by airline personnel anywhere in the world or through the Atlas Copco sales and service organisation established in 90 countries.

TWO MODELS

Air Partner M-3 consists of two identical units, each including a compressor connected to a standard petrol or diesel engine, for starting, air conditioning, de-icing and checking auxiliary systems, Air Partner M-2 consists of one rotary screw compressor connected to a standard petrol or diesel engine for starting and limited air conditioning.

THE *Atlas Copco* AIR PARTNER

A contribution to the jet age of air travel

Contact your local Atlas Copco company or agent or write to Atlas Copco AB, Stockholm 1, Sweden

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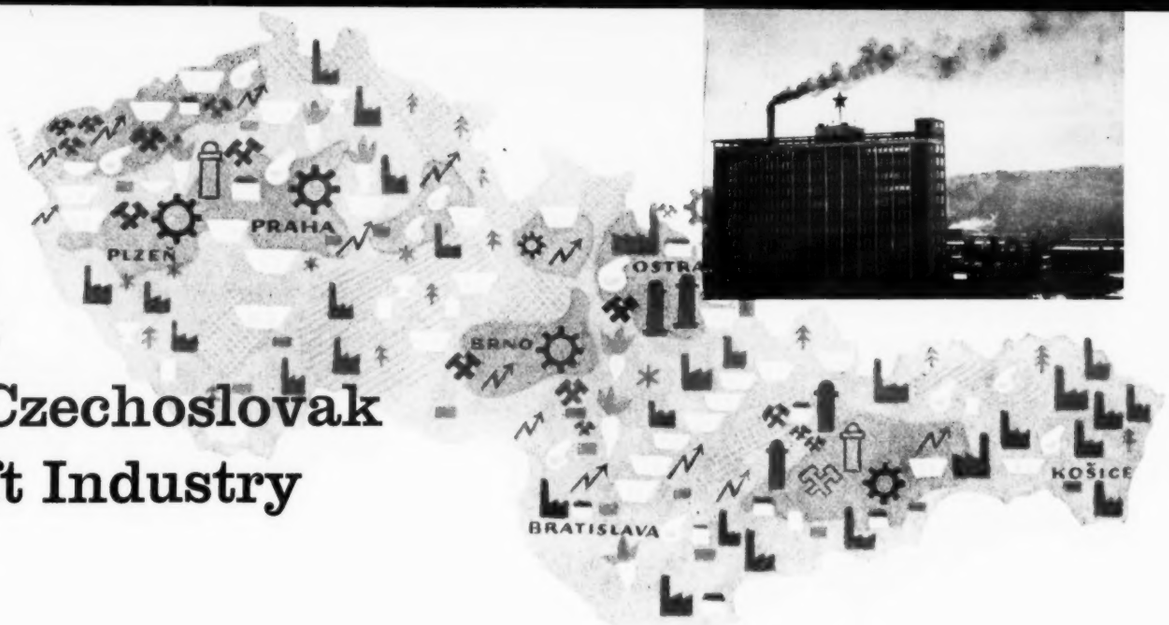


A Visit to the Czechoslovak Aircraft Industry

By E. Baur, Interavia

The Ceskoslovenske Aerolinie Ilyushin Il-14 settled down for a landing... At Prague-Ruzyne Airport I was awaited by Engineer Kachlik of Omnipol, who was—as on a previous occasion—to be my guide through a country where industrialization has made rapid strides during the past few years. I had been invited by Omnipol (the foreign trade organization for the import and export of sports and commercial aircraft, aircraft engines and equipment) to spend a few days visiting some of the Czechoslovak aircraft manufacturing plants.

First a few figures which show the progress of industrialization during the past five years. The volume of foreign trade in 1958 exceeded the 20,000,000,000 Crown mark,[1] an impressive performance for a relatively small country with only about 13,500,000 population. The average increase in industrial output between 1948 and 1957 was 11.7 percent per annum, and between 1937 and 1956 the index of industrial production rose from 100 to 266.

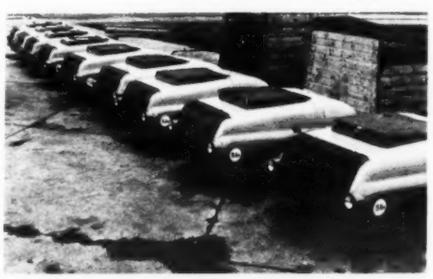
During my stay in Czechoslovakia the "second five-year plan for the development of the people's economy" was approved by the National Assembly. Under this plan the volume of industrial output in 1960 is to be roughly fifty percent higher than in 1955. Railway traffic in ton-kilometres is to be raised by 61 percent, and road traffic by 55 percent. No figures have been published on the traffic performance of domestic air transport, but it is safe to say that agricultural services and air taxi services have substantially increased during the past few years and can be expected to go on increasing.

The "Statistical Yearbook for 1957"[2] reveals that aerial taxi services alone carried roughly 195,000 passengers in 1956, compared with 139,000 in 1955 and only 52,000 in 1950.

Similarly Agrolet, a subsidiary of Ceskoslovenske Aerolinie responsible for agricultural duties, operated more than 12,000 flying hours in 1957, providing crop-spraying services, etc. for over a million acres of land. Under a programme of rationalization and improved efficiency Agrolet has undertaken a rapid modernization of its fleet during recent months, converting it primarily to the Czech-produced L.60 *Brigadyr*. Within the near future the organization is also to receive helicopters of the HC.2 *Heli-Baby* type, with M.110 105 h.p. engine.

[1] Around $2,000,000,000, depending on the rate of exchange used.

[2] "Statisticka Rocenka Republiky Ceskoslovenské 1957", published by Orbis, Prague.



From the production programme of the Otrokovice aircraft plant: left, the *Herkules III* motor winch, which is turned out in large numbers; right, the new Z. 326 two-seat trainer with 160 h.p. Walter *Minor 6-III*.

The Otrokovice "triumvirate": Commercial Director Miroslav Kuba (left), Chief Engineer S. Zamecnik (centre) and Chief Pilot Leopold Brabec.

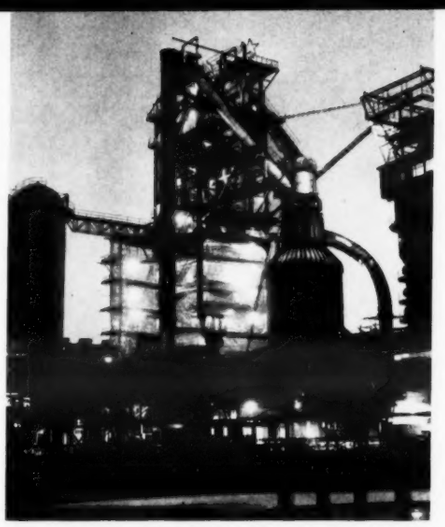
Twenty-five years of aircraft manufacture at Zlin

Nothing daunted by streaming rain and clouds reaching down into the tops of the surrounding woods, acrobatics ace Blaha flew our small party rapidly and comfortably to Otrokovice in the twin-engine L.200 *Morava* which Omnipol had thoughtfully provided for my travels. Our programme for the day included a visit to the plant which for many years past has been turning out the well-known Zlin series of sports aircraft and trainers.

These factories recently celebrated their 25th anniversary, so my visit could not have been more timely. Twenty-five years ago the Otrokovice plant began building sailplanes and gliders, later followed by a good number of powered aircraft; up to the present day more than 2,500 sports aircraft and trainers and some 1,000 sailplanes have been sold throughout the world.

Today the production programme at the Otrokovice plant, which includes manufacture of the *Herkules III* motor winch (exported in large numbers), is oriented chiefly to the production of the two-seat Zlin 226 *Trener* trainer, the new, more advanced Zlin 326 *Trener Master* and the HC.2 *Heli-Baby* lightweight helicopter.

Under the expert, close-knit control of the Otrokovice "triumvirate", Commercial Director Miroslav Kuba, Chief Engineer S. Zamecnik and Chief Pilot Leopold Brabec, the plant is working intensively on production and flight testing of the new Z.326 and on the HC.2 two-seat helicopter. Of particular interest is the Z.326, which differs from its immediate predecessor type, the Z.226, in a number of structural improvements, though these have necessitated only minor changes in the production set-up. A valuable feature for the user is that it can be flown as a single-seater from the front seat, and has full acrobatic capability as a two-seater. The span and hence the wing area of the Z.326 are slightly bigger than in the earlier models; and the new *Trener Master* has a retractable undercarriage.



Part of the Klement Gottwald foundry and steel plant, now in construction...few countries have experienced the same degree of industrialization in recent years as Czechoslovakia.

Engineer Josef Vyskoc, Vice-Minister for General Engineering, who exercises overall control over the Czechoslovak aircraft industry (left), and Engineer Ladislav Hlavsa, head of the Central Administration of the Aircraft Industry.

Leopold Brabec was not to be deterred from giving a masterly flight demonstration of the Z.326 and even prevailed on me to make a short flight, although at the time I was actually fully occupied in digesting a copious meal. Despite the brief time at my disposal, I was able to ascertain that in flying qualities the *Trener Master* is if possible superior to the older Z.226, has very good handling qualities in the stall and a low stalling speed. Moreover, thanks to the retractable undercarriage, the manufacturers have raised the top speed by a further 10 m.p.h.

The HC.2 helicopter was shown in public for the first time at the 1957 Brno Industries Fair, since when it has undergone extensive operational testing. Today it is just going into quantity production, with reportedly an initial batch of 200 planned for Czechoslovak and export requirements. Although my question as to "things to come" was answered only with an expressive wink, it seems to be certain that the HC.2 and its developments have a long career ahead of them . . . which would not be surprising in view of its qualities.

*

Mikrotechna — airborne and test equipment

My quarters for the night were in the Hotel Moskva at Gottwaldov (Zlin). Here the church and the village square are the sole remnants of the old country town of Zlin, out of which today's Gottwaldov, an industrial city *par excellence* and headquarters of the nationalized Bata concern, has arisen at a breath-taking pace. Characteristic features of Gottwaldov are its endless forest of factory chimneys and an apparently ceaseless growth in its population, which rose from 8,600 in 1921 to 58,000 in 1957.

About half an hour's drive from Gottwaldov is the modernly-equipped Mikrotechna plant at Uherske Hradiste, near Kunovice, the leading producer of airborne instruments, aircraft and ground radio equipment and test installations.

Immediately on my arrival, Chief Engineer Strba introduced me to a local custom. The handsome beer mugs from the potteries round Gottwaldov are greatly appreciated and are seldom found dry. But let us remain sober . . . as stated, Hradiste produces the latest aircraft instruments and at present radio equipment sets for a good-sized batch of *Super Aero* touring aircraft which is to be supplied to Russia's Aeroflot. The production programme also includes transmitter/receivers suitable for use at smaller airfields. Finally, the plant

Super Aero 4-to-5-seat touring aircraft, with two 105 h.p. Walter *Minor 4-III* engines, 130 of which have been ordered for delivery to Russia's Aeroflot.

HC.2 *Heli-Baby* two-seat lightweight helicopter, which is now going into production at Otrokovice.

L.200 *Morava* 4-to-5-seat touring aircraft, similar to the one which Omnipol placed at the writer's disposal – complete with aerobatics ace Blaha as pilot – during his tour of Czechoslovakia.

Strojirny Prvni Petiletky, Kunovice... Engineering Plant of the First Five-Year Plan at Kunovice: birthplace of the universally-known *Super Aero* and L.200 *Morava* twin-engine touring aircraft. Manager of the Kunovice plant is Vaclav Havranek (left); right Engineer Ladislav Smrcek, designer of the L.200.

is engaged on the development and production of related test equipment, which is assembled in the form of small field laboratories for use in the testing and calibration of instruments and equipment components.

Birthplace of the Super Aero and Morava

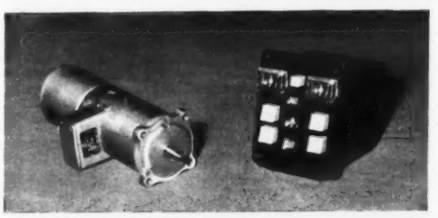
Strojirny Prvni Petiletky Kunovice ... literally Engineering Plant of the First Five-Year Plan, Kunovice, was the scene of my next visit. I hope that Manager V. Havránek and Chief Designer Engineer Ladislav Smrcek, father of the L.200 *Morava,* have forgiven me for the tardiness – properly speaking inexcusable, but understandable under the circumstances – with which Engineer Kachlik finally "delivered" me into their care.

At the Kunovice aircraft plant production of the *Super Aero* twin-engine touring and multi-purpose aircraft is in full swing, and Omnipol signed a contract with Aeroflot last April for the delivery of 130 aircraft of this type to the Soviet Union. As is known, the *Super Aero* has also been exported to many other countries, particularly in South America.

Taking the index for 1955 as 100, exports of Czechoslovak sports and touring aircraft increased to 257 percent in 1956 and to 446 percent in 1957. There is doubtless many an industry on both sides of the Iron Curtain which will look on such export figures with envy, particularly as deliveries were made to more than 45 countries.

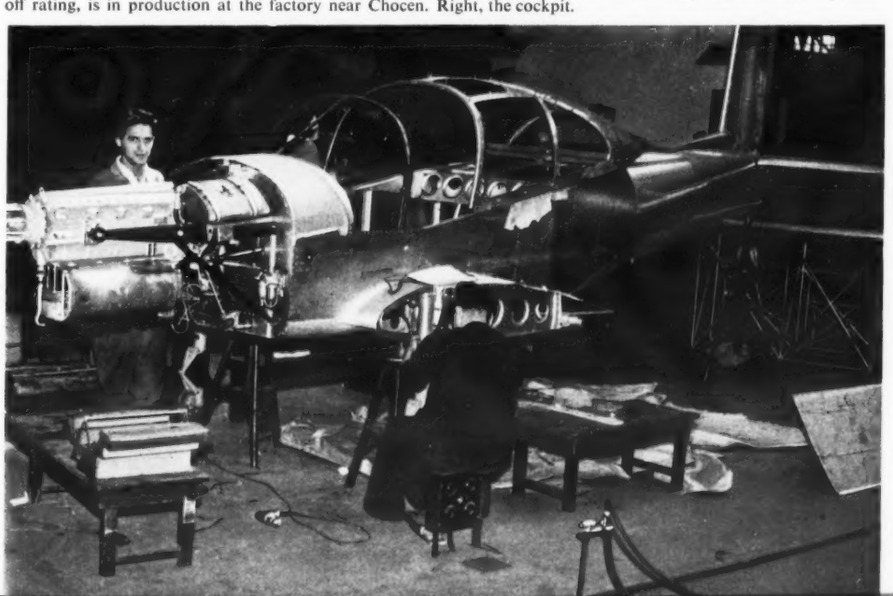
Brigadyr and Meta Sokol

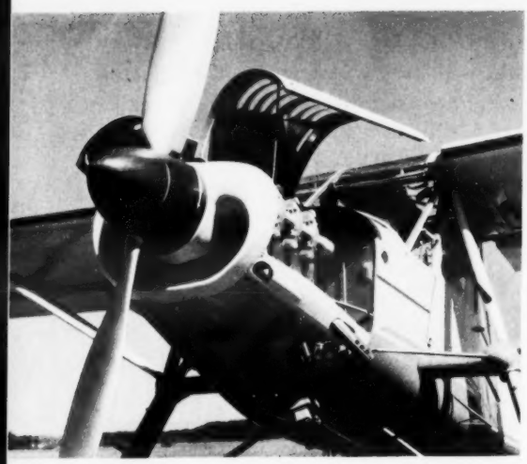
My last call on this tour was at the aircraft factories at Chocen. Once again our small party – Pilot Blaha, my escort Engineer Kachlik, our "court photographer" and your reporter – embarked in the trusty *Morava*, this time under almost hopeless meteorological conditions. However, the flight from Otrokovice to Chocen was uneventful. Here we made a brief tour of the workshops, where production of the L.60 *Brigadyr* multi-purpose aircraft is continuing, and that of the new *Meta Sokol* is just beginning. The *Brigadyr* has long been a familiar figure on the world market and has proved itself throughout the world. Today foreign sales of the *Meta Sokol* are being pushed with equal vigour, and this four-seat low-wing monoplane aroused considerable interest at the 1958 Autumn Fair in Zagreb, Yugoslavia. The *Meta Sokol* is powered by the new Walter *Minor Sc* engine, with compressor and low-



From the production programme of the Mikrotechna plant at Uherske Hradiste, near Kunovice: LUN 3521 VKP 10 airborne VHF radio station (top, centre), as produced in quantity for the *Super Aero*. To its left, the corresponding ground station. Centre: control unit and actuating relay for propeller pitch variation in a twin-engine aircraft. Bottom: checking the above-mentioned airborne station on vibration equipment, also built by Mikrotechna.

The L.40 *Meta Sokol* four-seat sports and touring aircraft, with Walter *Minor Sc.* (M332) engine of 140 h.p. take-off rating, is in production at the factory near Chocen. Right, the cockpit.





The L. 60 *Brigadyr* multi-purpose aircraft (220 h.p. Praga *Doris M*. 208 B), also produced at Chocen, is in world-wide use. Pictures show the engine installation, the efficiently equipped cabin and the production shops. The aircraft can be manufactured with a minimum of jigs and machine tools.

pressure injection, which delivers a take-off power of 140 h.p. for an installed weight of 225 lb. and gives the aircraft a speed of up to 140 knots.

*

No fewer than three small aircraft were needed to transport us from Chocen, where the runway was sodden and "zero-zero" conditions prevailed, to a small alternate airport, where we climbed into our *Morava* for the flight back to Prague—we were anxious to get back there the same evening. Flying conditions were so bad that we had to skim along on a level with the highest trees and factory chimneys; from time to time an inquisitive MiG put in an appearance, especially in the neighbourhood of Prague.

Prague-Ruzyne was closed to all traffic. Immediately Blaha headed for a nearby military airfield, so that I quite unexpectedly had a brief glimpse of some of the MiG-15s, MiG-17s, Il-28s and Il-14s which today are standard equipment for the Czechoslovak Air Force. Quite between ourselves, there was a goodly number of these aircraft parked on the airfield.

*

There is still much that could be told . . . of my visit to CSA's technical installations in Prague, the airline's operational experience of its first three Tupolev Tu-104A jet transports, of my latest talk with Engineer Hlavsa, head of the Central Administration of the Czechoslovak Aircraft Industry.

But my last hours in Prague were spent principally on a tour of inspection of Prague Airport, where an extensive modernization and expansion programme is in progress. New workshops and laboratories for the inspection and maintenance of aircraft equipment have already been taken into use, and the inauguration of an ultra-modern engine workshop for both piston engines and jets is scheduled for the near future. Further plans provide for the erection of new passenger terminal buildings, while new runways (the longest to measure 10,000 ft.) will be opened in 1961.

CSA's three-type fleet

Since the recent contract signed by Ceskoslovenske Aerolinie and Omnipol for the sale of CSA's 22 DC-3s to a British company, the Czech airline's fleet is now in principle to concentrate on three main types, the Avia 14, Ilyushin Il-18 and Tupolev Tu-104A (later probably also Tu-104B). However, the CSA fleet will continue to include a relatively large number of taxi aircraft, in particular of *Super Aeros*, L.60 *Brigadyrs* for special duties, and later L.200 *Moravas*. At the time of my visit the Avia plant had just announced a new version of the Avia 14, the 14T model designed for cargo work and ambulance duties. This aircraft, like its predecessor, can also be used without further modification for military purposes, in case of need.

Conclusions

It is particularly difficult to draw any general conclusions from the varied impressions obtained during this trip, as the aircraft industry in Czechoslovakia is still in the course of build-up. A pointer towards future developments was given by Engineer Hlavsa of the Central Administration of the Aircraft Industry, who remarked that a certain decentralization of production was now being aimed at, with the object of giving the individual plants a greater degree of autonomy. On the other hand central planning for the whole of aeronautical research is envisaged in the near future, following the satisfactory results obtained during recent years from similar coordination of production.

The immediate goal of the Czechoslovak aircraft industry is to increase the output of existing touring aircraft and turn out new designs in this field. And Engineer Hlavsa stated that the production of six-to-eight-passenger aircraft is to be considerably expanded in the future.

One thing is certain: the citizens of Czechoslovakia make far greater use of small aircraft for everyday travel than do those of the rest of Europe. The Czechoslovak industry, moreover, can always be reasonably sure of a market for its products, thanks to the far-reaching centrally-controlled industrial co-operation which exists between the Eastern *bloc* countries—the kind of cooperation which Western Europe is endeavouring to achieve but which all too often seems to break down in the face of national interests.

Faster but more expensive?

The U.S. Airline Industry Strikes

The airline industry is today facing the serious question of whether and how it can fill its commercial jet airliners. One possible solution would be to reduce fares and rates. However, this would first of all require a reduction in overhead expenses. And as salaries and wages constitute a decisive proportion of these costs, the airlines oppose any salary increases or changes in working conditions which would involve new costs.

Therefore it was definitely not a good moment to launch a strike wave which, involving as it does a wide variety of personnel categories, is a very serious liability on the U.S. airlines' annual accounts. As there are no clear-cut front lines in this most recent conflict in the United States' commercial airline industry, it is anything but easy to get a clear picture of the situation.

The parties, the method...

The best way to understanding would seem to be to introduce the conflicting parties and listen to their arguments:

- On the one side are the domestic and international *airlines*, which are being attacked by their personnel for various reasons, depending on their activities and aircraft (overseas traffic, long-range or local services, etc.).
- On the other side are a number of *unions* whose aims are to a certain extent diametrically opposed: the pilots belong to the *Air Line Pilots Association* (ALPA) which in turn belongs to the AFL-CIO labour organization. The flight engineers are represented by the *Flight Engineers International Association* (FEIA), a smaller professional organization which also belongs to the AFL-CIO and which is now being backed up by the powerful Teamsters Union (whose members include road transport workers). The *International Association of Machinists* (IAM) looks after the interests of the ground engineers.
- *Mediation procedures* were laid down by the Railway Labor Act, extended to cover the airlines in 1936.

The Railway Labor Act prescribes certain "cooling off periods" (30 days notice to be given prior to the termination of a contract, etc.) for talks between the parties and provides for two mediation authorities (National Mediation Board and Presidential Emergency Boards to be created as necessary by the President of the United States) which make suggestions to the parties on how to reach agreement... It is another question, however, whether or how far the parties decide to follow these propositions. Mountains of statements and documents have accumulated since mid-1957, in efforts to avoid the present labour conflict in the airline industry. The report on the proceedings of the Emergency Board handling the case of "ground engineers versus seven airlines"[1] contained no less than 12,162 pages... with the following success: Capital went on strike for 37 days and is now in anything but an enviable financial position, 5,383 ground engineers from Eastern Airlines came out on strike, and 6,700 from TWA (in the meantime the TWA personnel have returned to work).

But this was not all. Pan American World Airways was forced to cut down its European jet services on account of a pilots' strike but made an attempt to ward off the most serious consequences by putting nineteen "non-union executives"—among them a genuine vice president—into the cockpits of its Boeing 707s. A similar strike of flight personnel at American Airlines was temporarily avoided by a last-minute injunction.[2]

In the meantime the airlines involved in the strike were not idle, but began to organize themselves in turn. Six leading companies—American, Capital, Eastern, Pan American, Trans World, United—decided to form a kind of strike fund, or rather to pool their total receipts to strengthen the paralysed companies... Whereupon the unions threatened to bring an anti-trust action.

...and the demands

The main reason for the *ground engineers'* strike was the demand for higher salaries, but also included a demand for certain health and welfare improvements and for the removal of restrictions on the right to strike. While the employees demanded a 49 cents increase in their basic hourly wage of $2.51, the airlines were prepared to offer only 40 to 41 cents; in the meantime most of the cases have been settled at a half-way figure.

The case of the pilots and flight engineers is more complicated and stubborn. Apart from massive demands for higher wages from the pilots, leading to heated controversies which are still going on, both flight personnel categories announced far-reaching requirements for alterations in working conditions.

Contrary to the ground engineers' strike, a basic importance attaches to this labour conflict, regardless of whether the actual strike situation has been cleared up or not by the time these lines appear.

Roughly speaking, the pilots have put forward the following demands on switchover to jet aircraft:

- Pay improvements for jet airliner pilots; for first pilots flying international services these should result in annual salaries of anything up to $45,000 (basic salary plus expenses: hourly pay, mileage pay, day-night differential, overseas pay, etc.).
- Shorter hours for pilots—the present 85-hour month to be cut to 65; also a cut in the maximum daily working time.
- Inclusion of a third pilot in jet aircraft.

The "third man"

At the present time Pan American, who has already inaugurated its jet services, and American Airlines, who intends to put its first Boeing 707 into service at the beginning of January 1959, are the most badly affected.

[1] Emergency Board No. 122: International Association of Machinists versus Eastern, TWA, UAL, Northwest, Northeast, Capital, National (Washington, September 15th, 1958).

[2] American Airlines pilots downed tools at midnight on December 19th.

Pickets of the Eastern Air Lines' flight and ground engineers in front of the Miami, Florida, terminal building.

The battle concerning the "third man" is not a two-sided but a three-sided struggle. The pilots want the third man in the cockpit to be a pilot, but meet the opposition of the airlines and the even more bitter opposition of the flight engineers. Pan American and American Airlines both declared that, come what may, they would not give in to the pilots' demand.

Eastern Airlines, who tried to settle the matter amiably, met with little comprehension. During the Emergency Board negotiations in summer 1958 the airline suggested giving flight engineers training as pilots and declared that it was prepared to carry these costs itself. "Nothing doing," said George Petty, President of the Flight Engineers International Association, "the third man must remain a flight engineer." ("We are fighting for our lives, and we are going to hold out" ... Petty is 28). On the other hand, ALPA demands flight engineering training for all pilots—naturally at the expense of the airlines.

At the time of writing PAA is striving to reach an agreement, but regards the prospects even more sceptically as its piston-engine aircraft pilots, whose working contract expires on December 31st, have joined their jet colleagues in demands for higher pay—19.5 percent for first pilots and 15 percent for second pilots.

Although the 1,500 American Airlines pilots are observing the above-mentioned strike injunction until further notice, the airline is by no means out of the danger zone. On the contrary, Clarence Sayen, President of the Air Line Pilots Association, hinted of what may lie ahead with his outspoken remark that American Airlines has the "worst goddamned labour relations of practically any industry".

As with the demand for shorter pilots' hours, the argument over the "third man" arises from the pilots' and engineers' fear that the jets' greater carrying capacity and shorter turn-around times will lead to unemployment. Admittedly, in the official discussions this argument is not brought up very often. The pilots argue that safety demands additional relief pilots in jet aircraft, while the airlines give warning of the economic dangers of the creation of featherbedding jobs (meaning payment for hours not worked or for the creation of unnecessary jobs).

Parties opposing the unions (left) *E. M. Goulard*, Pan American Vice-President Industrial Relations; (right) *Paul W. Kayser*, Vice-President Personnel, American Airlines.

C. N. Sayen, President of the Air Line Pilots Association.

Assault on the cash-box

Moreover it is obvious that all three demands would entail a considerable financial burden for the airlines.

As far as the increase in salaries and wages is concerned, *Stuart G. Tipton*, President of the Air Transport Association, emphasized, during a speech before the Rotary Club of Boston on September 24th, 1958, the fact that the average annual wage in the airline industry is well above the average in other transportation fields and in the nation generally. For 1956 the following average annual wages were paid out: all industry $4,021, railroads $5,081, waterways, pipelines, etc. $5,158, highways $5,166, airline industry (flight and ground personnel) $5,474.

What is more, he added, the pilots of today already receive prima donna salaries. In 1957 no less than 696 American long-range pilots earned between $20,000 and $25,000, while the maximum salary for presidents of local service airlines was fixed by the CAB at $20,000. The average salary of a captain was $17,718 in the long-range trunk industry and $22,288 in the international field.

The wage demands are a serious financial threat to the airlines. The annual payroll of America's airline industry is at present around $800,000,000 and represents 46.1 percent of its total operating costs[2].

So much for the case put forward by ATA President Tipton; to be quite fair the counter-arguments by ALPA President Clarence N. Sayen must also be given:

Tipton's arguments are misleading, he maintains. Tipton only mentions the maximum wages, while numerous pilots have to work for annual salaries of $4,200. The average pilot's salary is neither $17,000 nor $22,000, but rather slightly above $12,000. Pilots have to fly for many years as co-pilots before they have a hope of becoming captains, and Tipton's remarks applied only to the latter...

Moreover, said the ALPA, the fact must not be overlooked that pilots have shorter working lives in their profession than other professional men.

"Package deals" declined with thanks

In view of both the financial problems in the airline industry and the keen competition —international competition, competition between national and private companies, scheduled versus independent airlines—the suggestion is occasionally put forward that working conditions for airline personnel should be standardized, on a national or even international scale (an international agreement would have to exclude the question of wages).

But even if theorists favour such "package deals", the more practical people reject them very definitely.

On a national scale? At its conference held in Miami on November 7th, 1958 ALPA decided, among other things, the "continuation of collective bargaining on a company-by-company basis, rather than industry-wide negotiations which it said would create instability".

And an international-scale agreement? Two years ago the International Labour Organization summoned a meeting of employers and employees from the aircraft industry; this was held from November 26th to December 5th, 1956 at the International Labour Office in Geneva... and ended in spectacular failure. For the first time in the history of the International Labour Office, one of the parties (the employers) refused to consider any kind of negotiation.

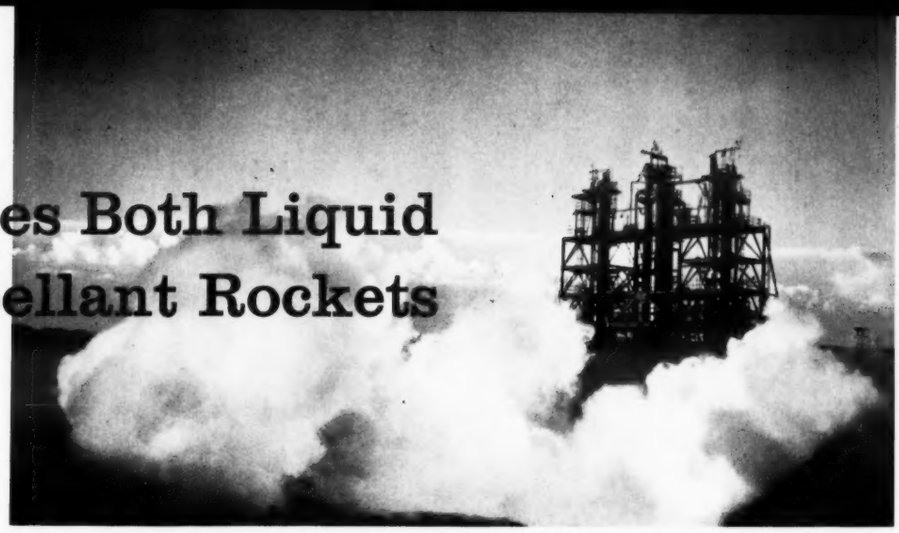
All the same the ILO did not abandon all hope of agreement, but decided to convene a three-sided conference (employer-employee-government) for 1960 or 1961, provided that "the annual ILO budget is big enough to cover the costs of such a conference". But even if these costs could be covered, there is still the question of whether or not it would be worthwhile.

600 flight engineers on strike leaving the hangar.

[2] In the European airline industry wages and salaries represent a slightly lower percentage of the total operating costs than in the USA: Swissair (1957) total overhead expenses 186,000,000 Swiss francs, wages and salaries Sw. Fr. 70,000,000; Lufthansa (1957) total expenses DM 156,000,000, wages and salaries DM 48,000,000; Air France (1957) total expenses approx. 80,000,000,000 French francs, wages and salaries Fr. Fr. 30,000,000,000.

Two Irons in the Fire

Aerojet Produces Both Liquid and Solid Propellant Rockets



Giant test stand for liquid-propellant rockets near Aerojet's Sacramento, California, plant.

Whatever may be the final outcome of the battle between liquid and solid propellant proponents, Aerojet-General Corporation has the comfortable assurance that it will come out on the right side. At its Sacramento, California, plant it is producing both liquid-propellant *and* solid-propellant rocket motors. At any rate it will have the necessary experience to cope with developments in all branches of rocket construction. A subsidiary of the General Tire & Rubber Company, of Akron, Ohio, it is already reputed to be the United States' largest industrial producer of liquid and solid rocket propulsion systems.

Aerojet's diversified facilities have resulted in an enviable list of Department of Defense contracts—no less than 98 percent of its total business is military. When the company recently received an Air Force contract for the second and third stages of the solid-propellant *Minuteman* ICBM, it was already working on solid propulsion systems or boosters for the following weapons: the Navy's Lockheed *Polaris* IRBM, Chance Vought *Regulus I* and *II* missiles, the USAF's Douglas MB-1 *Genie,* Hughes *Falcon* and Douglas *Sparrow II* air-to-air missiles, the Douglas *Nike Hercules,* Convair *Tartar* and Raytheon *Hawk* surface-to-air missiles, the Martin *Bullpup* air-to-surface missile and the Boeing/Martin *Dyna-Soar* project for an intercontinental glide bomber.

On the liquid-propellant engine side, Aerojet has contracts for propulsion systems for the USAF's Martin *Titan* ICBM, the Navy's *Vanguard* second stage, the USAF's *Bomarc* surface-to-air missile and the Aerojet *Aerobee Hi* research rocket. The latest highlight in the company's short but dramatic history is provided by the new production and test facilities at Sacramento.

*

This history begins in 1937 when Dr. Theodore von Kármán, the world-renowned aerodynamicist and then Director of the Guggenheim Aeronautical Laboratory at the California Institute of Technology in Pasadena, California, led a small group of graduate assistants in an investigation of rockets, using privately contributed funds. The outbreak of World War II in 1939 led to discussions between General H. H. Arnold and Dr. von Kármán and to initial Air Corps support for expanded research and development. One year later the first of the famous jet-assisted take-off (JATO) solid motors, a 25-pound thrust model, became available for testing.

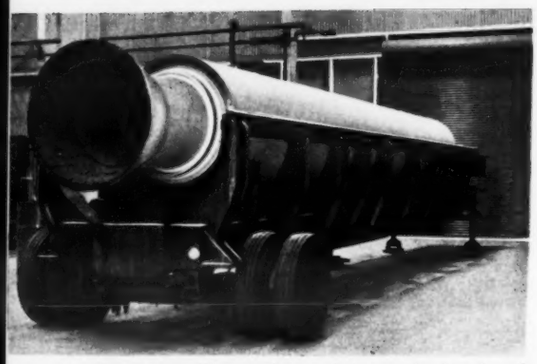
America's entry into World War II in 1941 intensified the need for rocket research and a quick transition from laboratory models to production output. Unable to interest any established engineering or manufacturing firm in the programme, Dr. von Kármán and his four key technical assistants formed The Aerojet Engineering Corporation in Pasadena in March 1942. Development and mass production of both liquid and solid propellant JATO units for both the Army and the Air Corps followed until June 1944 when the little company, extremely long on professional talent, but woefully short on financial know-how, sold its controlling interest to long established General Tire & Rubber Company.

With the end of World War II, the firm purchased its present plant in Azusa from the U.S. Government and cut personnel to a key minimum. Then began Aerojet's climb from 400 employees in 1946 to more than 13,000 today; from annual sales of $2,500,000 to $162,000,000 in 1957. Sales in 1958 are expected to have totalled $180,000,000.

Dan Kimball has headed the Corporation continuously except from January 1949 to January 1953 when he served successively as Under Secretary, Assistant Secretary for Air, and Secretary of the Navy in President Truman's adminis

Part of the Aerojet production facilities for preparing and casting solid propellants. Most of the buildings are protected by earth revetments.

Aerial view of the main plant near Sacramento. In the centre row of buildings from top to bottom are: the liquid rocket manufacturing plant, its office building and cafeteria, the liquid rocket plant administration and engineering building, the liquid rocket developmental and research shops, and a warehouse. The two buildings in the left row are the solid rocket plant fabrication shop (lower) and the solid rocket plant administration and engineering building.



This large solid-propellant rocket was developed and tested by Aerojet in conjunction with the *Polaris* programme.

Aerojet boosters of the size of the take-off rocket shown here are used for ramp launching of the Navy's *Regulus II* missile; launching thrust more than 50 tons.

Tilting bells in the solid rocket plant casting and curing buildings. The empty rocket chamber is slid into the bell and erected vertically, whereupon the propellant is cast into the bell and cured.

Control centre of one of Aerojet's liquid rocket test stands. The *Titan* ICBM's twin booster assembly can be seen on the centre television screen above the control desk.

trations. A. H. (Art) Rude is Executive Vice President and W. E. (Bill) Zisch, Vice President—General Manager.

Aerojet's founding father, Dr. von Kármán, has kept his hand in company affairs as Chairman of its Technical Advisory Board. Evolved in 1947, the latter meets several times each year to analyse and suggest technical activities, to advise management on policies and to make long-range plans. A bold and wise creation from the outset, the Board today is comprised of scientific experts Dr. Clark B. Millikan, Dr. Bruce H. Sage, Dr. Homer Joe Stewart, and Dr. Fritz Zwicky, all of California Institute of Technology; General Omar Bradley, former Chairman of the Joint Chiefs of Staff; Admiral Calvin M. Bolster, U.S. Navy; Major General Arthur W. Vanaman, USAF; all retired officers.

Left to right:

Aerojet President Dan A. Kimball.

William E. Zisch, Vice President – General Manager.

Richard D. Geckler, Vice President in charge of the Solid Rocket Plant.

Management and fiscal policies of Aerojet-General since World War II have been bold and at the same time circumspect, due in large measure to the financial cushion afforded by General Tire which today owns more than 87 percent of the company. Aerojet has an amazing record for reinvestment of earnings in new facilities. It currently owns 43 percent of its facilities and equipment, possibly the highest figure in the industry.

Aerojet's far-flung operations are headquartered at Azusa, California, a suburb of Los Angeles, but its two giant rocket plants—liquid and solid—are located 450 miles to the north near the State (California) capital of Sacramento. An area comprising 20,000 acres in the foothills of the Sierra Nevada Mountains, dredged barren by California's goldminers over the past century, it is now a $100,000,000 site for solid rocket facilities activated in 1951 and the liquid plant established in 1955. Two dams, two rivers and a large hydroelectric plant ensure adequate power (150,000 kVA) and water (10,000,000 gallons a day, enough to supply the daily needs of a city of over 40,000 population). The entire facility represents an investment to date of $80,000,000 (both company and military) for buildings and equipment, with $2,500,000 more in buildings under construction. Approximately $20,000,000 in additional capital outlay is anticipated by the end of Fiscal 1959.

*

Aerojet describes its approach to the rocket propulsion business at Sacramento as a "comprehensive approach to a specific field". Problems in research, development, testing or manufacturing liquid and solid rocket propulsion systems are approached on the broadest possible basis. The company evidences strong interest in newer and better propellants, plastics and metal fabricating techniques and almost every type of engineering or laboratory technology used to find better ways of doing things for both liquid and solid rocket propulsion systems. Interest is centered on rockets and underwater propulsion and does not extend to other fields such as turbojets, ramjets and other air-breathing engines. The two plants have the potential to develop and test solid rocket motors of more than 20 million pounds-seconds total impulse and liquid rocket engines delivering up to 1½ million pounds thrust. Each plant has its own administration, engineering, testing, and manufacturing facilities, with common service functions.

Though the facilities of both plants are completely integrated and organized along product lines to implement these interests, there is considerable difference in the facilities needed at each plant owing to the difference between liquid

Manufacture of combustion chambers for liquid engines in one of the Sacramento shops.

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INTERAVIA

REVIEW OF WORLD AVIATION

and solid rockets. In the solid rocket field, a large part of the work lies in manufacturing the solid propellant itself. This is primarily a chemical engineering operation which does not exist at all in the liquid plant. The liquid plant, on the other hand, buys the propellant from the manufacturer and need only engineer the use and application of the fuels.

There are other points of difference. For example, there is more static testing with liquids. Liquid systems have rotating parts such as pumps and turbines, valves and related control systems that require more test equipment than solids. Liquid engine configurations are such as to allow a particular piece of hardware to be run over and over again merely by refilling the tanks. By contrast the solid rocket is a single integral unit that must normally be expended during every test firing. A test can be repeated only by firing and expending another unit. Liquid engine proponents feel that this is a particular advantage to the liquid systems, that reliability can be demonstrated and attained by firing over and over again. This is difficult and costly to accomplish with a solid rocket.

Essential differences between solid and liquid rocket technology require separate personnel in specialized problem areas, but Aerojet feels that the two plants have sufficient problems in common so that many personnel are interchanged. Liquid personnel work on solid problems from time to time, and vice versa.

The Solid Rocket Plant at Sacramento is headed by Vice President Richard D. Geckler, a 40-year-old JATO expert. He is assisted by Vienna-born Dr. Karl Klager (formerly of the I.G. Farbenindustrie's main research laboratory) as manager of the Solid Propellant Development Division, Dr. Ernest R. Roberts as manager of Solid Rocket Research and Development, and Werner R. Kirchner, associate manager and chief project engineer on *Polaris* engine development.

With its interest and emphasis evenly divided between liquids and solids, Aerojet Sacramento plays no favourites between the two competing systems. Geckler says the solid rocket business is growing faster than the liquid and that this trend will persist but will level off.

Dr. C. M. Beighley, Liquid Rocket Plant Research Development head, agrees that solids are making rapid progress into new applications not previously considered, such as large ballistic missiles and space flight. However, it remains to be demonstrated, he says, whether they will prove out as intended. Meanwhile, at Aerojet, liquids are moving to meet the competition from solids with new propellants, much larger and lighter engines. The great advantage of the solid is its simplicity, maintain Aerojet engineers. The higher performance of liquid propellants combined with some complexity is opposed by the somewhat lower performance combined with simplicity of the solid. Solids, say Aerojet liquid people, started out as simple as a tin can, but are getting more complex as they are called upon to do more and more of the guidance and control activities that liquid engines have already accomplished, such as vector control and thrust termination. With solids requiring more hardware they are losing a principal advantage over liquid engines; i.e., simplicity. However, solid motors for military applications have the distinct advantage of simplicity over the current liquid engines, since they can be stored or set-up without further attention. Liquids have the greater performance, and with more exotic fuels this lead is being extended.

Dr. K. Klager, head of the Solid Propellant Development Division (left), and W. R. Kirchner, project engineer for the *Polaris* engine, discuss a new solid-propellant charge.

Beighley feels that for applications requiring optimum performance the difficulties in handling liquid fluorine, for example, can be tolerated to obtain the extra performance.

One of the real areas of Aerojet interest is density; i.e., the amount of energy that can be packed into a given volume, expressed as density impulse. At the present time solid propellants are denser than liquid propellants, so a solid motor can be smaller in volume than a comparable liquid engine.[1] However, Aerojet feels it is possible, thanks to its work on new liquid propellants of very high density, to equal the solid developments in this area. Under development are halogen (fluorine, bromine and chlorine) compounds for use as oxidizers. Research is underway on metal hydrites[2] and on metals used as additives to liquid propellants. The most promising liquids being studied for ultra-high energy systems are liquid hydrogen and fluorine. Both are very hard to handle due to reactivity and extremely low temperatures. Ozone and the free radicals, either as additives or as mixtures in other liquids, are still in the laboratory stage at Aerojet, and a lot of work remains to be done before they can be used.

Aerojet feels that its research development in liquid engines has already scored on actual hardware such as the *Titan* liquid propellant engines, which are described as representing the most advanced configurations of this type in use today in the United States and possibly in the world.

[1] Including combustion chambers, pumps, controls and tanks.

[2] Hydrites are chemical compounds containing in addition to hydrogen one, or in special cases, two other elements; metal hydrites are alloy-type solutions which hydrogen forms in conjunction with certain metals.

The Aerojet engineers are confident that, from their work on the *Titan* programme, they could design a 1½ million pound liquid rocket and know that it would work. In addition they feel that the 1½ million pounder should be built immediately to meet all the space and commercial applications under study.

Advances in solid propellants are also being made. Because solid motor design must take the propellant parameters and work them into actual performance, the development of solid propellants must lead that of the actual motors by three years, says Aerojet's Dr. Klager. The trend in solids is to higher specific impulse: the current figure is about 240, but in Aerojet Laboratories there are solid propellants of about 250–260 specific impulse which are expected to be in production by 1961–1962. One of Aerojet's major solid programmes, now in the middle of its development phase, is the *Polaris* engine. Described by Dr. Roberts as a revolutionary concept, the Polaris propulsion system is a planned sequence of two powerplants, each with its own level of utility. Under test now at Cape Canaveral is the first article powering the test vehicle.

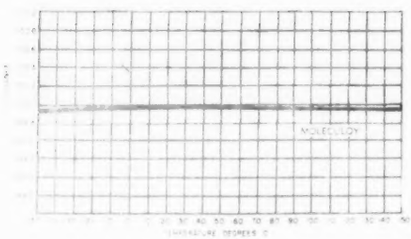
What does the future hold for Aerojet, Sacramento? The company feels its Sacramento facilities will continue their growth towards a real integrated centre of rocket technology under the stimulus of the National Aeronautics and Space Administration. Aerojet views NASA as giving a powerful boost to rocket propulsion for both weapons and peaceful uses. A visible sign of the company's forward-looking policy was the establishment two years ago of an Astronautics Research Laboratory, followed by the creation of a new subsidiary, Aerojet-General Nucleonics. Though originally founded to study nuclear propulsion for rockets, the latter soon expanded beyond this narrow framework and has since sold more low-power industrial and research reactors than any other U.S. undertaking.

Aerojet today is a pulsing centre of dynamic activity and enthusiasm that brushes off on the visitor. At Sacramento the observer senses that Aerojet is facing the present and the future with confidence and optimism, based on past accomplishments and on the fact that at present only 30 percent of total expenditure is devoted to production, with the remaining 70 percent going on research and development.

Two of Aerojet's liquid rocket test stands near Sacramento. Each can take engines the size of the *Titan* booster. The control centre, from which the test engineers follow the whole sequence by television, is housed in the sand-packed shelter in the centre of the picture.

Telecommunications and Electronics

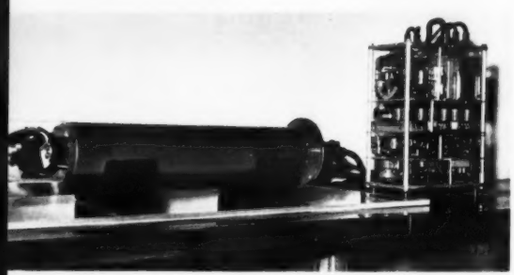
● A new fine wire made of a new alloy called Moleculoy is now available from **Molecu-Wire Corp.**, Scobeyville, New Jersey, for use in resistors, potentiometers, etc. According to Edward Edmunds, Executive Vice President of the company, Moleculoy was developed to meet the growing demand for an alloy that combines maximum resistivity and a very low temperature coefficient. Moleculoy maintains its temperature resistance characteristics over temperatures ranging from —65°C to +250°C, possessing a very low thermal EMF (Electro-Motive Force) vs. copper (significant in aircraft, guided missiles, etc.). Moleculoy is essentially a non-magnetic 75/20 nickel chromium alloy, modified with additions. It is available in diameters ranging from .010-inch to .0004-inch, in bare, enamelled, oxidized and fabric-covered finishes. Laboratory tests have revealed excellent oxidation and corrosion resisting qualities. The high tensile strength and high yield



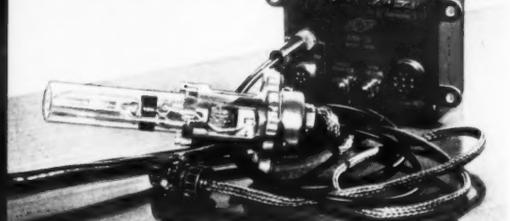
strength allow rapid winding speeds even in the finest sizes, while its low thermal expansion minimizes distortion and movement in windings. Moleculoy can be soldered, brazed or welded. The diagram shows the resistivity of Moleculoy (in percent) plotted against temperature (in °C).

● The Electronics Department of **Ferranti Limited** has brought out a new micro-spot cathode ray tube (5/71 CM) capable of resolving 5,000 lines and particularly suitable for airborne applications such as aerial mapping. The diameter of the spot is considerably less than 1/1,000th of an inch (0.0254 mm). The high resolution is obtained by the use of an extremely fine screen and an entirely new design of electron gun using two focusing elements, one of them electromagnetic and external to the tube, the other electrostatic. Since multiple effects due to e.h.t. ripple, imperfect focusing and poor scanning fields can cause critical enlargement of the spot, Ferranti has developed special scanning and focus coils for these tubes, together with a small alignment magnet which is clamped to the neck of the tube near the cathode.

Russian satellite instrumentation



Magnetometer (plus appropriate electronics) for measuring the earth's magnetic field. Note the orientation mechanism for the probe with the aid of which the satellite's position in relation to the direction of the earth's magnetic field is determined.

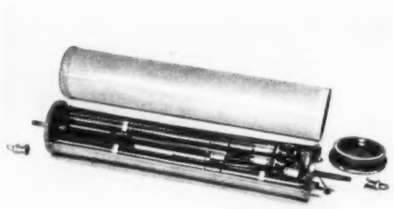


Ionization manometer (with DC amplifier) to ascertain atmospheric density at great altitudes. Basically the equipment measures the number of positive gas ions produced in the gas by the electron flow of a triode, the interior of which is connected with the ambient gas.

Mass spectrometer (with appropriate electronics) to measure the distribution of ions in space.

● To facilitate the detection of small life-boats or isolated persons in distress by rescue aircraft or ships, without demanding unnecessary effort from those in difficulty, **Telefunken G.m.b.H.** has developed an automatic sea rescue D/F transmitter designed solely to mark the position of the accident. This is a small one-watt transmitter, enclosed in an entirely watertight plastic casing, with built-in ferrite antenna and battery for three days of automatic operation. As soon as it is placed in the water—from sinking ships or aircraft—it begins to transmit radio signals at short intervals on the sea rescue frequency of 2,182 kc/s; these signals can be received by ships or aircraft within a radius of roughly 20 nautical miles, and enable rescue craft to steer towards the scene of the accident.

The transmitter's range is increased considerably if it can be operated from even a few inches above

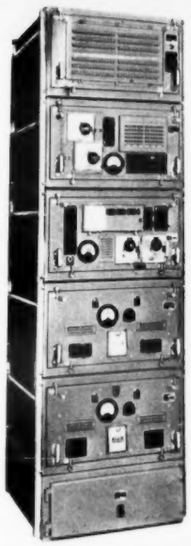


the surface of the water, for example in a boat. However, the range of 20 nautical miles offered by the transmitter in the water would seem sufficient, as rough details of the position of the accident are generally known.

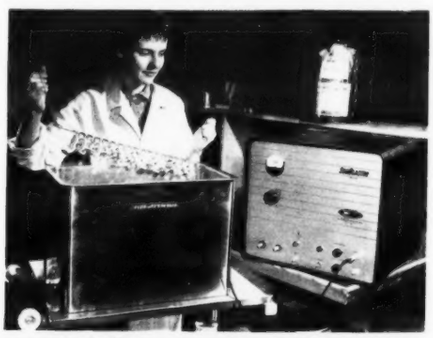
● **Compagnie Française Thomson Houston** has developed a sub-miniaturized emergency beacon transmitter for air-sea rescue service; in addition to automatically radiating a modulated signal (A2), the device can also be used for R/T (A3) simplex transmission/reception. The equipment is available in two versions, either with valves (Type TH.C.985) or transistorized (Type TH.C.986). The two basic components are completely watertight, and the equipment has a life of over 30 hours and weighs only 1 lb. The emergency transmitter is switched on by a pull-ring which at the same time releases the folded antenna. For R/T working, range is 30 miles, and 60 to 75 miles for key. Frequencies in the 238—248 Mc/s band can be pre-selected, and with certain modifications also in the 119—224 Mc/s band.

● The **Lockheed Missile Systems Division** has developed a magnetic tape recorder for space vehicles. It is so rugged that it was able to successfully withstand simulated rocket launches of 50 times the force of gravity. Known as AMR-100 (*A*irborne *M*agnetic *R*ecorder), the unit weighs 8 lb., and measures only 9 in. × 5 in. × 4.5 in. A special feature is an easily changeable cartridge containing a 600-foot endless loop tape which records two tracks of information simultaneously for a maximum uninterrupted period of 96 minutes. It is powered by synchronous motors so that data can be recorded and recovered with an automatic and accurate time reference (reproduced at six times the recording speed).

● The Amherst Engineering Laboratory of Sylvania Electronic Systems, a division of **Sylvania Electric Products Inc.**, has developed for the Air Materiel Command a semi-automatic emergency rescue radio beacon transmitter, whose signals can be received by ground direction-finding networks, enabling aircraft crashes to be located. Designated AN/ART-31, the unit measures 32 × 9 × 9 in. and weighs less than 50 lb. It can be carried in aircraft, life-boats etc., where it can be set in operation immediately in an emergency. It can also be dropped by parachute. Once in operation, the AN/ART-31 transmits coded signals at frequent intervals for 24 hours. A built-in flasher light aids in location at night.



● The **Plessey Company Ltd.** has developed a new, complete range of VHF/UHFradio-telephone equipment, which has been designed specifically to meet NATO requirements and which is already in use with the Royal Air Force and the Royal Navy. Both single and multi-channel versions, for either direct or remote control, are available, so that complete ground or shipborne communications systems can be engineered. Frequency range is from 225 to 400 Mc/s, and the equipment provides 1,750 channels with 100 kc/s spacing. Picture shows the 100-watt VHF/UHF transmitter station as used by the Royal Air Force for ground-to-air radio-telephone communications.



● The **Narda Ultrasonics Corporation** is massproducing a high-power ultrasonic cleaning system for industrial use, known as the Series 5000 SonBlaster. It consists of the 40 kc/s 500-watt Model G-5001 generator and the NT-5001 cleaning tank (20 in. × 12 in. × 11 in.). The generator can be used to energize up to ten Narda Model NT-605 transducers and is designed for use on 110-volt and 220-volt (50—60 c/s) power supplies.

● **De Havilland Aircraft Company Ltd.:** The de Havilland *Comet 4* Systems Trainer (pictured), the first of which is already in service with BOAC at London Airport, is designed for crew training and provides a representative range of instrument readings for both normal and emergency flight procedures. A Fault Introduction Console enables the instructor to simulate typical emergency conditions, which students then have to handle through appropriate drills. The Trainer can be used by six students at a time. No crew seats are provided, to reduce overall size, but the instrument panels are arranged so as to be at normal eyeline.

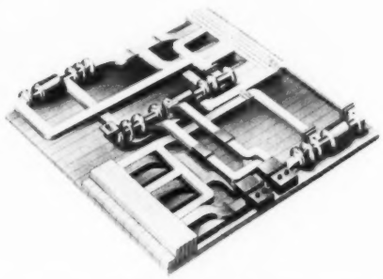
Bendix Doppler Radar System

The Bendix Doppler Radar System comprises five main components: antenna (ANA-12A), transmitter/receiver (RTA-12A), frequency tracker (DRA-12A), indicator (INA-12A) and control unit (CNA-12A). With the exception of the transmitter tube, the system is completely transistorized. Total weight, excluding wave guide and cabling, approx. 60 lb.

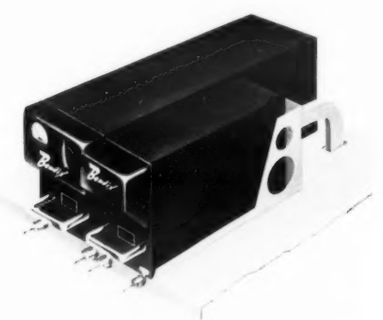
The antenna radiates four individual beams towards the earth's surface, where some of the radiated energy is reflected and received again aboard the aircraft. Because of the Doppler effect the frequency of the reflected signal differs from that of the transmitted signal, by an amount proportional to the aircraft's ground speed. The frequency tracker measures the frequency shift between the transmitted and the reflected signal, with a sequential switching circuit sensing the Doppler shift in each beam separately. The result obtained from each beam is stored during the switching cycle and then fed to a digital computer (in the frequency tracker), which calculates ground speed and drift. Next the digital values are converted into analogue signals to actuate the output data servos for the indicating system. Additional servos are provided to operate navigation computers.

The indicator (INA-12A), a standard 3-inch instrument, has a dial-type presentation for drift angle (up to 40° left and right) and a veeder counter display for ground speed (in knots). Flag alarms and a warning light are provided to indicate when malfunctioning occurs or when the echo signal is too weak, for example when flying over unusually smooth seas.

The control unit (CNA-12A) for the Bendix Doppler Radar System is designed for installation in the overhead instrument panel.



The antenna (ANA-12A), a four-beam system, is designed for rigid installation in the airframe. Over the major portion of the horizontal surface (26 × 24 ins. or 52 × 12 ins.) it is less than ¾ inch thick. The wave guide and ferrite switching assemblies on top of the antenna increase the thickness in this area to approx. 3½ ins. This design permits the antenna to be installed in extremely shallow recesses in the fuselage or wing. In addition, the antenna is constructed in two sections, one providing the radiators for the two forward beams, and the other for the two rear beams. The two sections can be mounted either one in front of the other or side by side, which greatly simplifies installation problems.



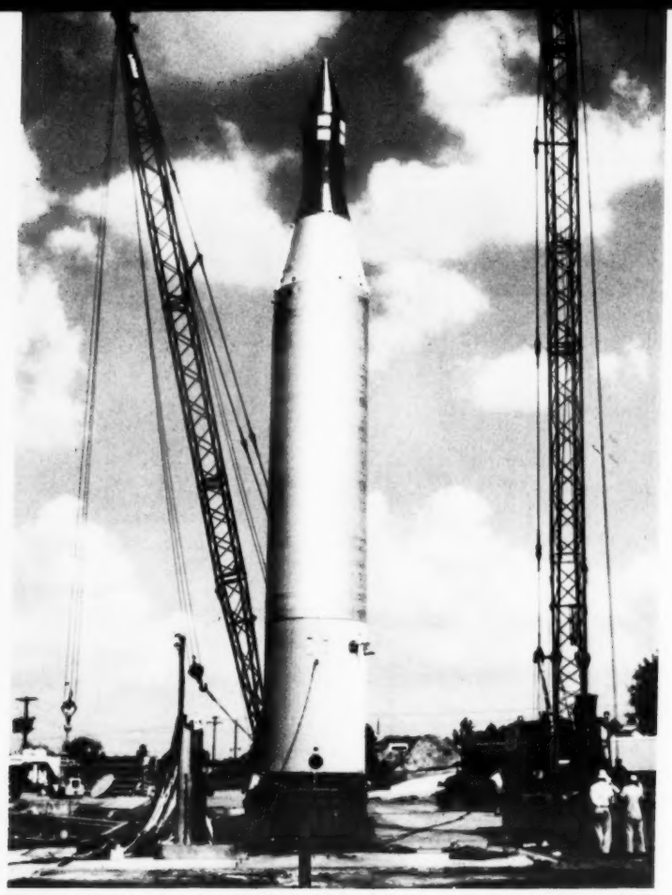
The transmitter/receiver (RTA-12A; shown on right) is housed—together with the cooling facilities—in a ⅜ ATR package. A single microwave connection is provided between the transmitter/receiver and antenna. The frequency tracker (DRA-12A; on left in picture) contains in a ½ ATR package the frequency measuring unit, sequential switching circuit for the separate antenna beams, the digital computer for calculation of ground speed and drift angle, the output data servos and the power supply regulators.

Ground speed data are provided with a tolerance of 0.6 percent plus 1 mile, and drift angle data within a tolerance of ±0.5 degree. Over smooth water these accuracies are somewhat lower, though a LAND-SEA switch on the control unit minimizes them. So that in determining drift angle it can make allowance for the aircraft's pitch and roll, the computer receives relevant information from the gyro. For the calculation of ground speed additional details are not needed, as pitch and roll are automatically eliminated in evaluating the Doppler shifts of the individual beams.

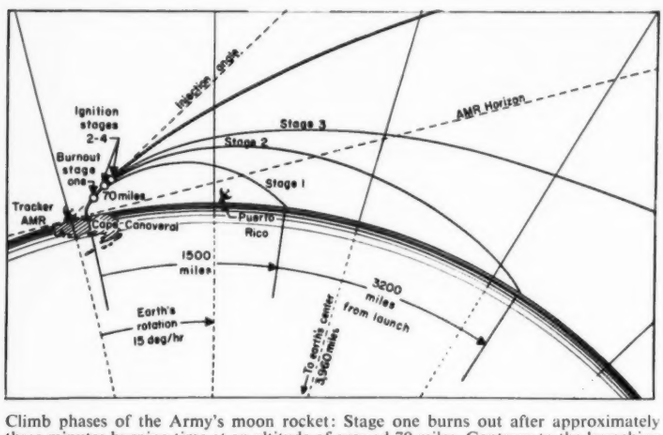
Other data

Power requirements:	115V, 400 c/s, 150 VA; 27.5V DC for operation of relays.
System type:	Frequency modulated continuous wave.
Frequency:	8,800 Mc/s.
Transmitter power output:	0.5 watts.
Receiver noise figure:	12 db.
Measuring range:	Ground speed from approx. 100 to 1,000 knots, drift angle up to ±40°.
Temperature range:	−40° C to +70° C.
Maximum operating altitude:	At least 50,000 ft. over smooth sea.

Rockets, Missiles and Space Vehicles



The U.S. Army's *Juno II* space vehicle, with which it was planned to shoot a 13-lb. payload past the moon into space.



Climb phases of the Army's moon rocket: Stage one burns out after approximately three minutes burning time at an altitude of around 70 miles. Contrary to the launching of an earth satellite, the injection angle of the second, third and fourth stages (each with a burning time of six seconds) is comparatively steep.

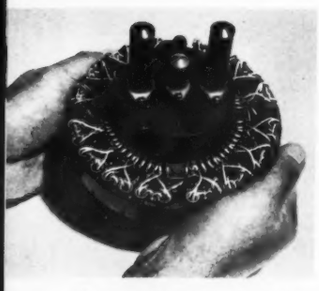
• The U.S. Army misses too...

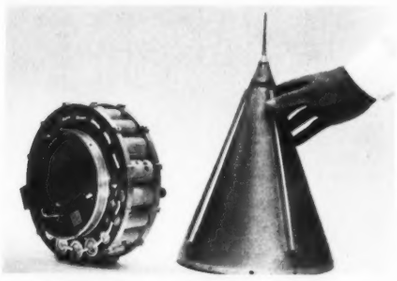
The U.S. Army's attempt at the beginning of December to launch a small instrument payload past the moon into space, with the aid of its four-stage *Juno II* carrier rocket, failed in its main objective, like the three earlier USAF attempts. Because of an error in the setting of the propellant regulator system, the first stage burned out 3.7 seconds earlier than planned. Consequently the instrumentation package (designated *Pioneer III*) attached to the fourth stage could not be raised to the required speed of more than 24,000 m.p.h., so that the satellite fell back to earth after attaining a maximum distance of roughly 66,650 miles and burned up in the upper air layers above the Sahara. Nevertheless valuable data were otained from the radiation counters aboard the *Pioneer III* during its ascent and descent which revealed new details of the radiation belt round the earth. The launching was carried out under the direction of the National Aeronautics and Space Administration with the cooperation of the U.S. Army Ballistic Missile Agency and the California Institute of Technology Jet Propulsion Laboratory, both of which are elements of the United States Army Ordnance Missile Command.

The *Juno II* carrier vehicle was roughly 76 ft. long and bore NASA markings. It was composed of the following rockets: first stage, U.S. Army *Jupiter* IRBM with lengthened airframe and larger propellant tanks (weight roughly 120,000 lb.); second stage, eleven *Sergeant* solid-propellant rockets in a rotating drum (weight 721 lb.); third stage, three *Sergeant* rockets inside the second stage (weight 207 lb.); fourth stage, one *Sergeant* rocket made of titanium instead of stainless steel in order to reduce weight to a minimum (weight 59 lb.). The conical satellite body, and some of the instrumentation, were supplied by the Jet Propulsion Laboratory; the body was 23 in. long and 10 in. in diameter. At its tip it carried a 3-in. aluminium rod which, along with the gold plating of the conical body, served as antenna. The satellite body was also painted with alternating black and white stripes to ensure adequate temperature distribution when only one side of the body was exposed to the sun's radiation.

Instrumentation included two Geiger counters for radiation intensities of up to 100 röntgen per hour, a special lens with photo-electric relay to shoot the moon on the way past, and a 960.05 Mc/s transmitter with mercury battery for 75 hours operation. So that a picture of the moon could be recorded, the spinning of the final stage (roughly 400 r.p.m.) was to have been braked by two small centrifugal weights of 7 grammes each attached to 60-inch wires and released by a time mechanism after about ten hours of flight.

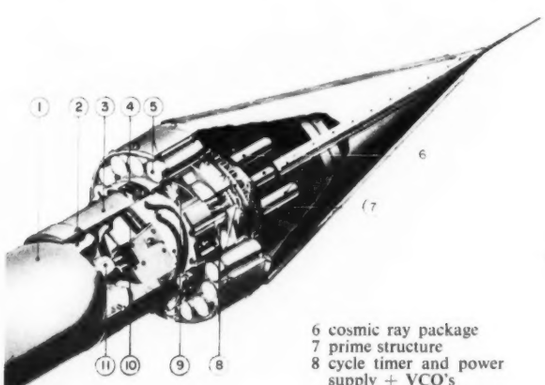
Some time this month the U.S. Army will attempt another moon launching with its *Juno II* carrier vehicle. It will utilize the experience gained on December 6th, 1958, and according to Wernher von Braun has better prospects of success.





The radiation measurement equipment in the *Pioneer III* consisted of two Geiger counters and a small voltage supply tube (lefthand picture) and revealed new details of the radiation belt round the earth.

The *Pioneer III's* measuring instruments (left of righthand picture) with batteries arranged in a circle around them and the photoelectric relay for recording the passage past the moon. The radiation counter is fitted on the back of the drum-shape instrument carrier. Right, the gold-plated conical casing with the transmitter antenna at its tip.



Cutaway view of the *Pioneer III*:

1 last stage booster
2 heat shield
3 adapter
4 clamp
5 battery pack
6 cosmic ray package
7 prime structure
8 cycle timer and power supply + VCO's
9 transmitter
10 trigger for separation from the fourth stage
11 centre separation

Side view of the *Juno II* carrier rocket.

● Data recovery from Sentry reconnaissance satellite

A new concept may be in the works for recovering intelligence data from the WS-117L *Sentry* reconnaissance satellite. During the early stages of the project, it was felt that the satellite would only be able to transmit its findings to an extensive complex of ground stations. But Pentagon officials have been talking about controlled re-entry of satellite vehicles. In this way the data would not become available to an adversary and would be easier to evaluate. In this connection, Roy Johnson, director of the Pentagon's ARPA, declared that the U.S. has a system for returning a satellite to earth within a radius of 50 to 100 miles of a selected point. The technique will be tried out in the forthcoming series of *Discoverer* shots.

● Project Discoverer

According to a statement by the U.S. Department of Defense, it is planned to launch a whole series of artificial satellites, some of which will carry small live animals. The first satellite of the Project *Discoverer* test series would probably be launched at the end of 1958 or early in 1959. The statement further reveals that the prime object of the first attempts would be to test the new rocket vehicle: a *Thor* IRBM as first stage, with a new Lockheed rocket (of undisclosed characteristics) as second stage. The first satellite to carry a laboratory animal will be launched around May 1959. This series is designed primarily to test and perfect the recovery method for earth satellites mentioned above.

● Midas early warning satellite

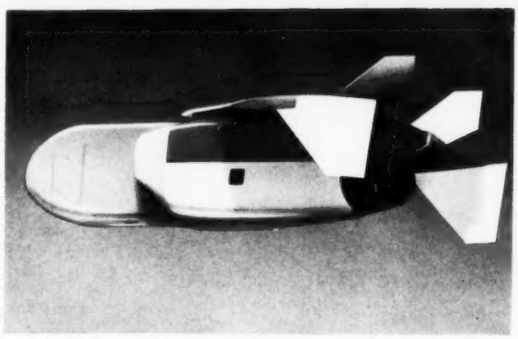
The Pentagon's Advanced Research Projects Agency is developing an early warning satellite called *Midas*. Reportedly, *Midas* will employ infrared equipment to detect the heat traces of ballistic missiles at high altitude.

● One-man weapon against low-flying aircraft

The U.S. Army plans to construct a light surface-to-air weapon, under the project designation *Redeye*, similar to a bazooka. It will be operational by one man against low-flying aircraft or helicopters. According to *Interavia's* Los Angeles Correspondent, this small rocket will possibly be fitted with an infrared homing head, which will automatically guide the weapon to the target.

● End of Rascal production

According to reports from Washington, the USAF has cancelled production of the Bell GAM-63 *Rascal* air-to-surface guided missile, as newer weapons are now ready for operation. A production contract, amounting to several million dollars, has also been cancelled, although the *Rascals* ordered some time ago have been delivered.

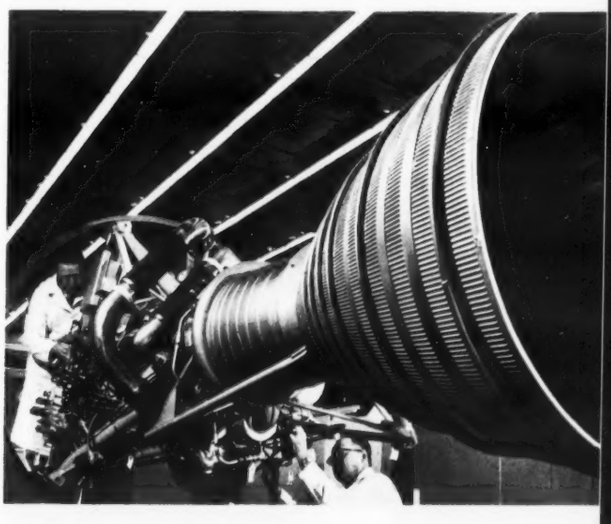


First air launching of a GAM-72 *Quail* decoy missile from a Boeing B-52 mother aircraft. The missile, developed by McDonnell Aircraft Corporation's St. Louis plant under contract to the USAF, is suitable for release from SAC jet bombers over enemy territory, when it would follow an entirely different course from the bombers so as to mislead enemy defences. For this purpose its payload includes extensive radar jamming and echo simulation equipment. It is powered by a General Electric J 85 jet of the 2,200 + lb. thrust class, with an air intake on either side of the fuselage. A striking feature is the small-span delta wing with four fins on its trailing edge.

● Successful full-range Atlas launching

At the end of November 1958, the USAF successfully fired for the first time a production *Atlas* ICBM, fitted with three rocket motors, over the full range of 6,325 miles. The missile is said to have fallen within 30 miles of the predetermined target area. The Air Force said that the firing "was one of a continuing series of research and development flight tests". It was the 15th test launching since the first *Atlas* firing in June 1957. The first SAC operational unit will reportedly be formed some time this year.

The Goldstone Tracking Station of approximately 85-foot diameter was built by the Jet Propulsion Laboratory (California Institute of Technology) in the Californian desert to receive the *Pioneer III's* signals.



Final adjustment on the Rocketdyne rocket motor for the first stage of the Army's *Juno II* moon vehicle.

Afterburner Design and Development in Sweden

By Östen Svantesson, Chief Installation Engineer,
Engine Department, Royal Swedish Air Board, Stockholm

The author, designer of all the afterburners hitherto developed in Sweden.

Early in 1950, when Sweden's J 29 jet fighter was already in full production, it became evident that the provision of additional thrust by means of an afterburner was highly desirable. To install an afterburner in the existing airframe was considered to be almost impossible under the given conditions. However, an attempt was made, and the result was a fully acceptable, if somewhat unconventional, product.

Since then the J 35 *Draken* and a later version of the J 32 *Lansen* have been equipped with Swedish-designed afterburners. Also a prototype for a *Hunter Mk. 4* afterburner has been developed and flight tested with good results.

The initial requirements for afterburner operation have progressively been extended; for example, the original requirement for reheat operation was only five minutes per flight, but today no such limitations exist. Likewise the requirement for satisfactory functioning at high altitudes has been raised to correspond almost to the basic engine limits. All afterburners in production to date have been designed to operate on kerosene and wide-cut fuel. They deliver the additional thrust at an outlet temperature of 1,650 to 1,900° K.

General aspects

In the design of an afterburner for a specific type of aircraft and basic engine, numerous limiting factors have to be considered:

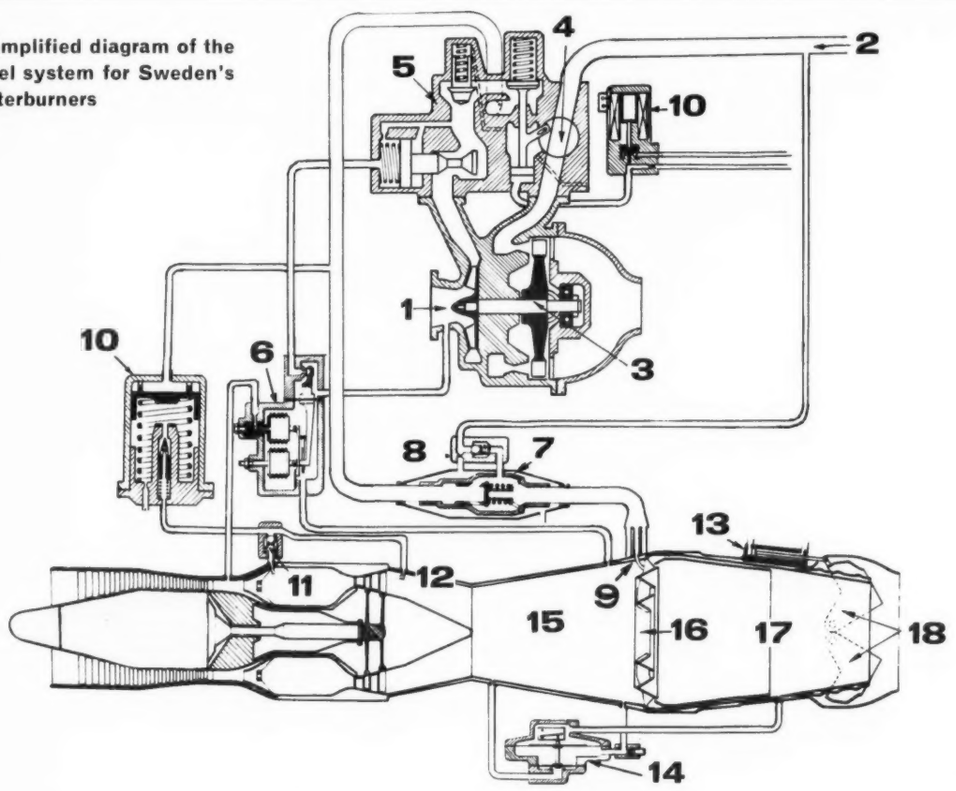
1. The space available for installation of the afterburner in the airframe may be too small for an ideal aerodynamic configuration of the afterburner chamber.

2. In order to achieve an even pressure distribution at the end of the nozzle, it is desirable to have a long combustion chamber, but in this case a larger proportion of the gas flow has to be utilized for cooling purposes. To be able to run the afterburner at temperatures around 1,900° K or above, it may be necessary to make the combustion chamber shorter.

3. Fuel distribution in the flame holder section must be very regular, and the free area in this section must be at least 25 percent larger than the maximum nozzle exhaust area. A relatively large number of flame-holder rings is desirable, but this causes greater mechanical difficulties.

4. Because of the risk of blockage, the fuel nozzles in the burners cannot be made as small – and hence as numerous – as desirable.

Simplified diagram of the fuel system for Sweden's afterburners



1. Fuel turbopump for afterburner (and fuel inlet)
2. High pressure air (from compressor)
3. Single-stage air turbine to drive the fuel pump
4. Compressed air throttle (two positions)
5. Fuel control unit (with horizontal, continuously variable metering valve)
6. Servo unit for fuel metering (controlled by the compressor outlet pressure and static pressure in the afterburner diffusor)
7. Non-return valve for the reheat fuel
8. Air venting valve to blow air through the injection nozzles after cut-out
9. Fuel injection system for the afterburner
10. Hot shot igniting solenoid valve
11. Combustion chamber of basic engine
12. Outflow confusor of basic engine
13. Hydraulic jacks (two) for the two eyelids
14. Flame-out control unit to control hydraulic jacks (13)
15. Afterburner diffusor
16. Flame holder
17. Reheat chamber
18. Eyelids to regulate the nozzle area

Furthermore a high pressure and a high flow velocity through the burners are required, to avoid the fuel's boiling at high altitudes.

5. The cooling gas flow must be strictly separated from the combustion flow, and fuel may in no circumstances be permitted to enter it.

Special design features

Under certain conditions it may be necessary to design a very short diffusor, but this presents some difficulties. This was the case for example in the afterburner for the J29's D.H. *Ghost* engine (see *Fig. 1)*, when the flame holder was designed to form an integral part of the diffusor. It should be stressed that the most important parts of an afterburner are the flame holders and the fuel injection nozzles, and that the principle of the Swedish design is to maintain a high temperature inside all the flame holder rings. As shown in simplified form in *Fig. 2*, a small amount of the total fuel is injected into the rings, and the remainder is injected in front of the rings upstream of the gas flow.

In order to control the local pressure in the flame holders and to avoid too strong a backflow, a number of holes have been drilled in the holders *(Fig. 4)*. These holes are also used to get a proportionally richer local gas mixture at altitude, for which purpose the fuel nozzles are located in front of the holes. This arrangement concentrates a larger amount of fuel around the nozzle, to compensate for the drop in fuel pressure at altitude.

To get information on how to maintain the flame with low fuel pressure, static tests were made at full r.p.m. with afterburner lit. The amount of fuel injected was then reduced to two to three percent of the maximum fuel flow, and it was found that stable burning could be maintained without altering the area of the outlet nozzle.

As regards the arrangement of the outer flame holder rings in relation to the flame tube (D), which acts as separator for the cooling flow (cf. *Fig. 2)*, the distance between these two parts depends entirely on the length of the flame tube. The same applies to the distances between the flame tube and the outer skin. Because of the high combustion temperatures, the thickness of the cooling layer and the length of the flame tube can be decided only after careful testing.

The diffusors for the various afterburners built in Sweden differ from one another depending on the installation conditions offered by the airframes concerned. In all cases it has been possible to achieve a high pressure recovery and a low Mach number in the section behind the flame holders. This has improved the efficiency and stability of combustion at altitude, even at very low pressures in the afterburner.

The outlet nozzles are of a two-position eyelid type, with a circular area in both positions. The eyelids are operated by means of a pair of hydraulic jacks. A manifold surrounds the nozzle rear and acts as an ejector for secondary air, thus providing adequate external cooling for the jet pipe. In some cases this manifold incorporates ram air intakes, when it functions as a supersonic nozzle.

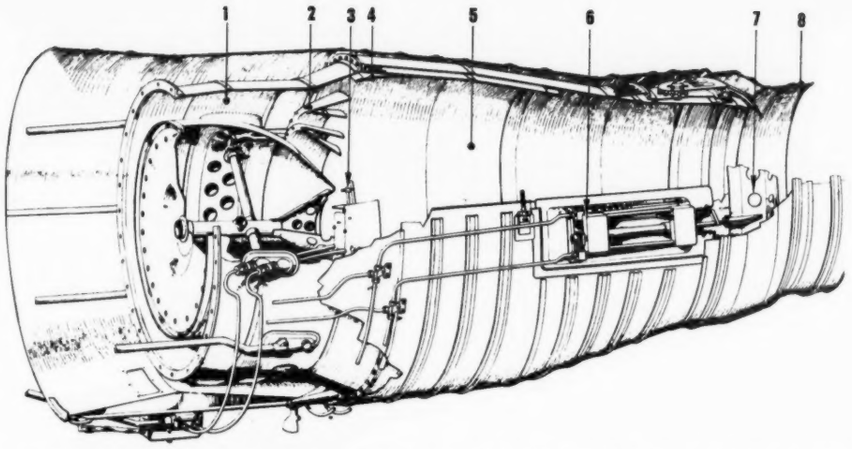


Fig. 1: Afterburner for the Svenska Flygmotor *Ghost* (de Havilland licence) in Sweden's Saab J29 fighter. 1. Diffusor portion of afterburner; 2. flame holders; 3. injection nozzles and rings; 4. flame tube to separate cooling air flow from reheat air flow; 5. reheat chamber; 6. hydraulic jack for lefthand eyelid; 7. lefthand eyelid to regulate exhaust area; 8. engine casing, cooled by secondary air.

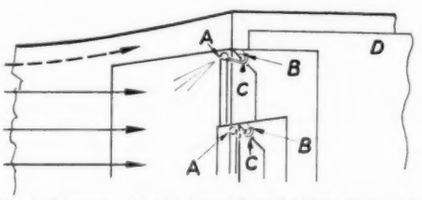


Fig. 2: Diagram of the V-shaped flame holders and double injection nozzles in an improved version of the *Ghost* afterburner: the gas flow from the basic engine is divided into the reheat flow (unbroken lines) and the cooling flow (broken line); the forward fuel nozzles (A) inject against the direction of flow and towards the centre of each flame holder ring, so that the mixing of the fuel with the gas flow takes place inside the rings; the rear fuel nozzles (B) inject into the bases of the rings; holes (C) in the inner flange of each flame holder regulate local pressure and ensure better mixing; the smooth outer flanges are designed to keep the gas flow as laminar as possible; far rear, the flame tube (D) to separate the cooling flow from the hot reheat flow.

Fig. 3: Segment of the double (four-row) injection system as shown in the above diagram.

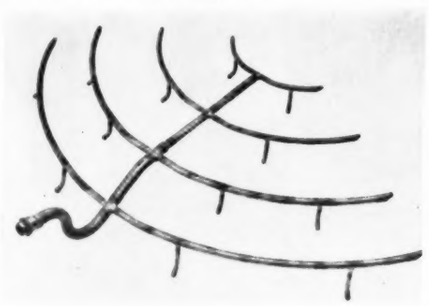


Fig. 4: Segments of the V-shaped flame holders with holes in the inside flanges.

The fuel system

The fuel system selected for the Swedish-designed afterburners is shown in diagram form in the drawing at the beginning of this article. The fuel pump (1) is driven by air (2) from the engine compressor by means of a one-stage axial turbine (3) mounted on the same shaft as the pump wheel. The air throttle (4) has two positions and is operated by the fuel pressure from the engine fuel system. The fuel metering valve inside the control unit (5) is controlled by pressure from the engine compressor on the one hand and by the pressure aft of the turbine, via servo unit (6), on the other.

Between the fuel valve and the burners, and as close as possible to the latter, is a non-return valve (7). This is combined with another valve, known as an air venting valve (8), which opens when the fuel pressure from the pump is shut off, thus permitting compressor air to blow through the fuel nozzles (9) to prevent the formation of carbon deposits.

To ignite the afterburner a solenoid-operated valve (10) is opened briefly, and small amounts of fuel from the basic engine's high pressure system are injected into one of the engine combustion chambers (11) and the "confusor" (12) aft of the turbine. This produces a long flame reaching from the combustion chamber through the turbine, which ignites the fuel injected behind the turbine; this in turn ignites the fuel in the afterburner flame holders.

The control valve for the jacks (13) operating the eyelids is itself actuated by a flame-out control unit (14). This device is operated by

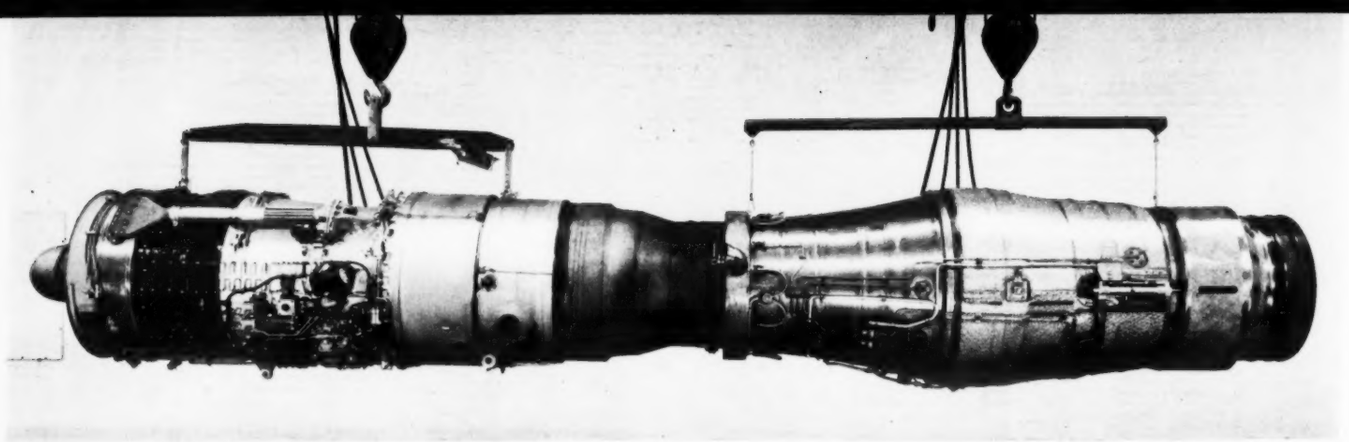


Fig. 5: Svenska Flygmotor *Avon* (Rolls-Royce licence) basic engine with its Swedish-developed afterburner for a recent version of the Saab J32 *Lansen*.

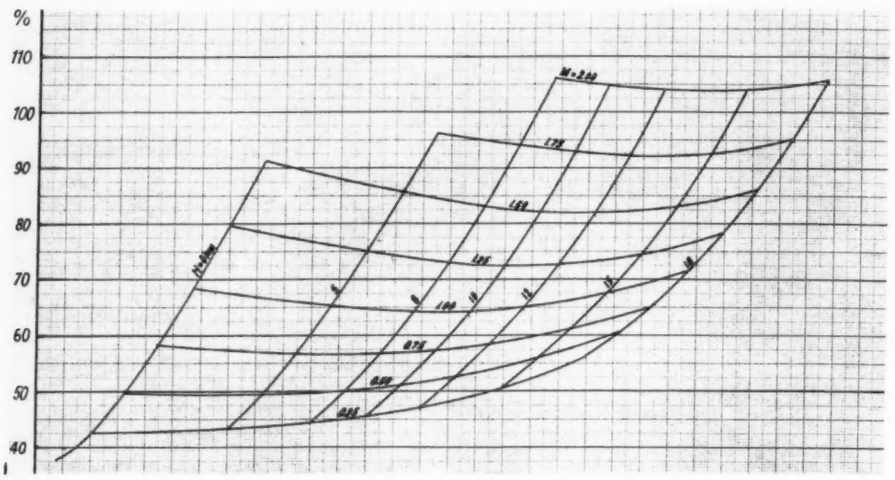


Fig. 6: Thrust augmentation (in percentages) obtainable through reheat, for various flight Mach numbers (M 0.25 to M = 2.0) and altitudes (0 to 18,000 metres or roughly 60,000 ft.).

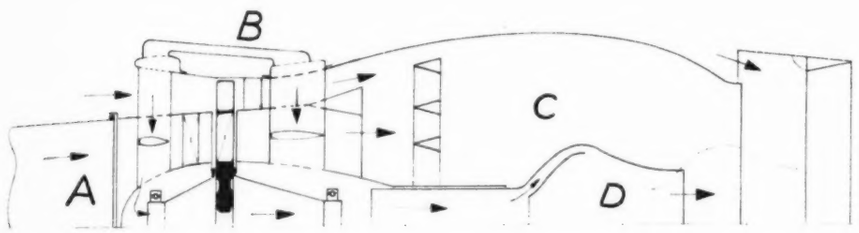


Fig. 7: Projected combination of an aft fan (B) and afterburner (C) to be used in conjunction with basic engine (A). The area of the exhaust nozzle is varied by longitudinal displacement of the central body (D), which is cooled by air bled off the aft fan.

Fig. 8: Recent model of an afterburner for the Saab J32B *Lansen* and the *Avon* engine.

static pressures picked up upstream of the flame holder and at the rear of the nozzle.

Development and manufacture

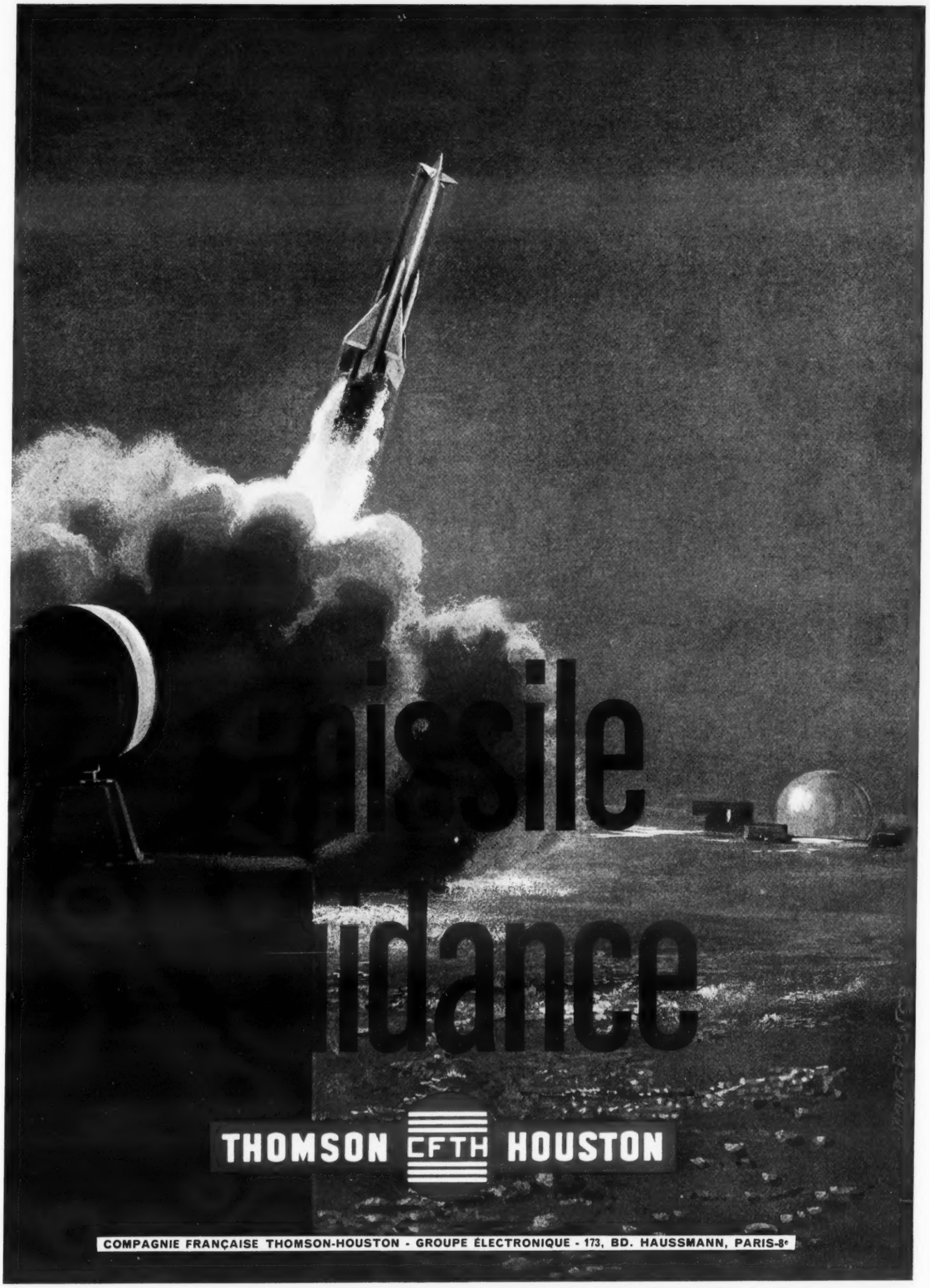
Two prototype afterburners for the J29 fighter were built by the Royal Swedish Air Force's central maintenance workshops at Malmslätt, while Svenska Flygmotor AB, of Trollhättan, has been responsible for manufacture of the production afterburners (and basic engines), as well as for the design and production of the afterburner fuel pumps and control systems.

Development work and bench tests have also been carried out at Svenska Flygmotor, where the necessary facilities* are available for running full-size engines at high ram pressures, using a chamber under 280 ft. of water pressure. Use of these test facilities greatly reduced the amount of testing required in flying test beds, and with one exception all afterburners have been installed in single-engine fighters for the initial flight tests. This exception was the J29, the afterburner for which was mounted, complete with its basic engine, in a pod beneath a bomber specially converted for the purpose. These flight tests were carried out at the Royal Swedish Air Force Test Centre at Malmslätt.

*

A promising line of development would appear to be an engine with an aft fan combined with an afterburner, as illustrated in *Fig. 7*. The additional air provided by the fan (B) can amount to as much as 150 to 200 percent of the basic engine air flow (A), thus creating considerable thrust augmentation for take-off and cruise. In this way it would be possible to achieve a low specific fuel consumption with reheat off, and high thrust (for low specific weight) with reheat on. In such an arrangement continuous variation of the nozzle area could be accomplished by longitudinal displacement of a central cone (D), which could be cooled by air from the aft fan. Last but not least, the lower noise level thus obtainable (with reheat off) would be greatly appreciated, especially on peacetime operations in the neighbourhood of populated areas.

* Cf. "Sweden's Unique Jet Engine Laboratory" in *Interavia* No. 7, 1951, p. 387, etc.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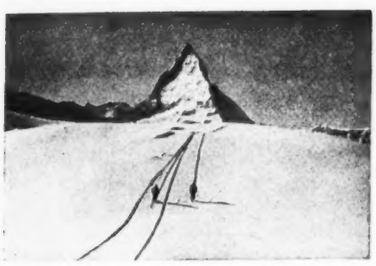

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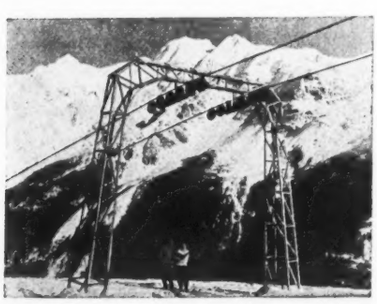

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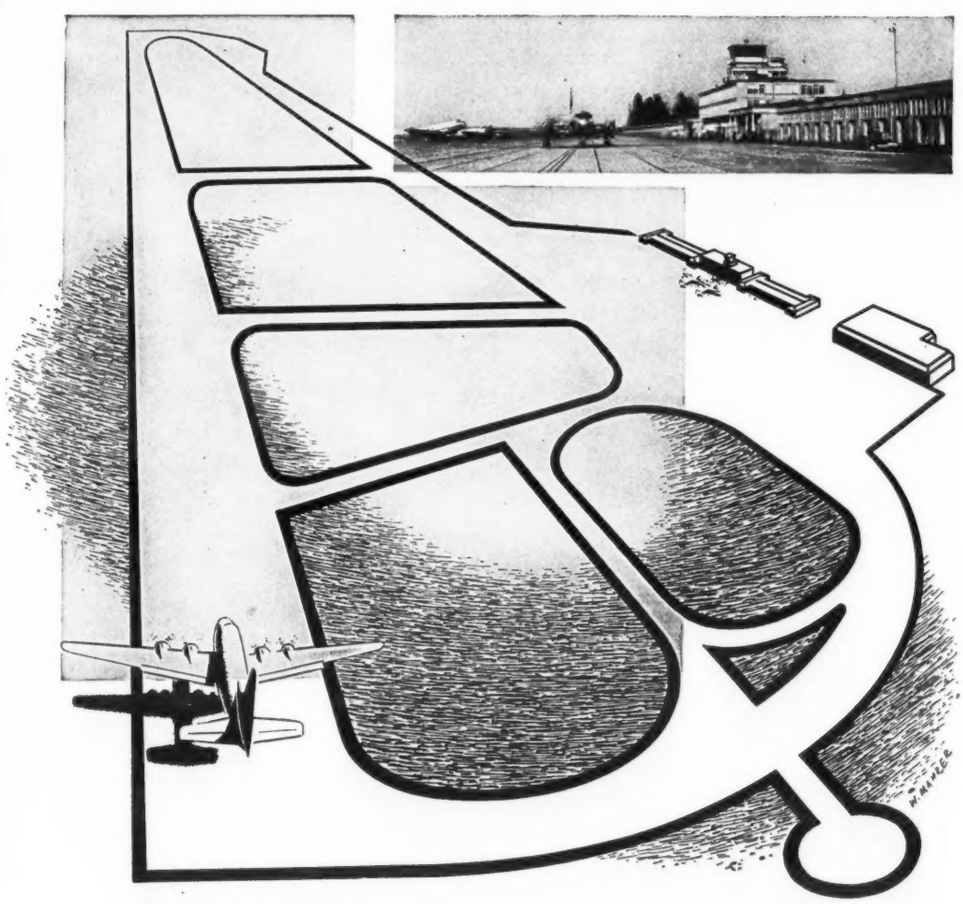

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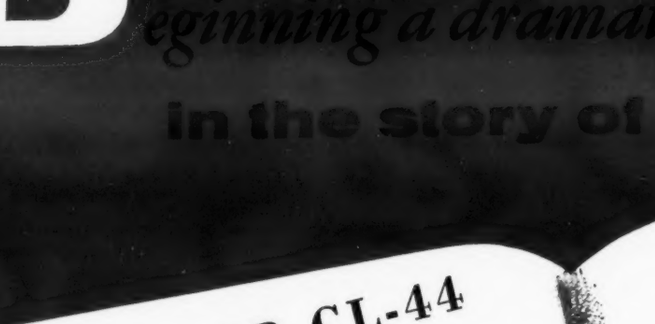

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A Compact Navigational Computer

By F. M. Kirr, Project Manager, Airborne Equipment Department, Librascope, Inc., Glendale, California

Systems engineering has been defined as "the technique that establishes maximum *compatibility* between input information, system components, and output requirements to obtain optimum *overall* performance." Overall performance of the system is, of course, the real objective. It entails many aspects of performance other than system output, and as such must be evaluated in the light of the pertinent factors such as cost, weight, time required in production, reliability, and maintenance.

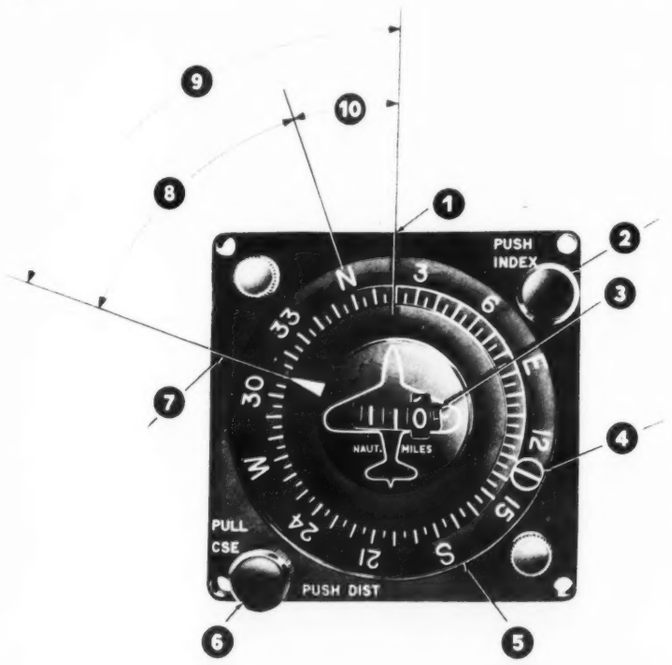
Cognizance of these basic requirements for airborne navigation equipment and close adherence to the systems engineering concept has resulted in a new, ultra-compact, dead-reckoning computer. Designated the Computer Set, Navigational—AN/ASN-9, the 6.5-pound instrument employs inputs of true airspeed, compass heading, magnetic variation, wind velocity, and wind direction. These data, complemented by the original course and distance to the destination, are combined to produce output displays of present ground track, and course and distance to destination. So effective has the systems approach been in the development of the ASN-9 that position errors of only 4 percent are experienced in flights of 500 miles range. Of this total error, the major source is the error in meteorological wind data.

Consisting of the two units shown in *Figure 1*, the ASN-9 is designed for instrument panel mounting. Manual settings for wind direction, wind velocity, and magnetic variation are provided on the computer control unit, which displays this information throughout the flight. Presenting ground track angle, course to destination, and distance to destination on a pilot's reference type of display, the indicator unit houses the computing elements. All angular information in the display is read from the compass rose portion of the indicator face. The needle representing aicraft ground track appears as an extension of the miniature aircraft planform fixed to the instrument face. To indicate ground track, the compass rose, printed on a movable dial, is rotated with reference to the fixed ground track pointer. Course to destination is read from the movable dial against the course-to-destination pointer. A three-digit counter displays the distance to destination in nautical miles. A connector for the power inputs of 115 volt 400 cps (75 VA) and 28 (12 w) volt DC is provided on the back of the control unit. True airspeed and compass heading information is received through a connector mounted on the rear of the indicator unit.

Error analyses set accuracy requirements

In the design of the ASN-9, the first application of the systems concept was in the determination of the accuracy requirements of the computer in the light of the accuracies available in the input information. Since the complexity of the computing components is determined largely by the accuracy requirements of the computations, every attempt must be made to exactly determine the acceptable limits on computing accuracy. Error analysis in this case determined that computer inaccuracies of 2 percent contribute less than 0.5 percent additional error to the overall system error over that contributed by a computer error of 0.5 percent. This can be verified by comparing the 2 percent computer to one of 0.5 percent inherent error in the following manner:

Fig. 2: The ASN-9 indicator unit: 1. Fixed pointer; 2. index setting knob; 3. distance counter; 4. ground track index; 5. outer dial; 6. course and distance setting knob; 7. course-to-destination pointer; 8. course to destination; 9. course error; 10. ground track.



Assuming:

ε_{V_A} = air speed error $\approx 2\%$

ε_{H_M} = heading error $\approx 1^\circ \approx 0.3\%$

ε_{γ} = magnetic variation error $\approx \frac{1}{3}^\circ \approx 0.1\%$

ε_{W} = combined wind velocity and direction error $\approx 3\%$

ε_{C} = computer error

The system error is found from the following equation relating data source and computer errors to the overall system error.

$$\varepsilon = \sqrt{\varepsilon_{V_A}^2 + \varepsilon_{H_M}^2 + \varepsilon_{\gamma}^2 + \varepsilon_{W}^2 + \varepsilon_{C}^2}$$

For a system with 0.5% computer error, the overall error is 3.65%; with 2% computer error the system error is 4.13%.

Examination of the results of this comparison, which utilizes estimates of the data source accuracies, indicates that the *advantages to be gained from extremely accurate computer sections are rather disproportionate to the penalties paid in weight and complexity.*

In a similar manner this same procedure may be applied to the individual computing elements that comprise the computer. In many cases in the ASN-9 the result of comprehensive error analysis has been a revamping of conventional approaches to dead-reckoning computation along with the introduction of weight and space saving techniques.

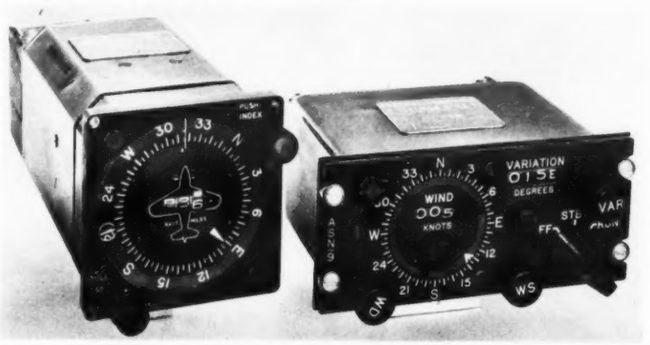


Fig. 1: The two units comprising the ASN-9 computer are designed for instrument panel mounting. Wind direction, wind velocity and magnetic variation are manually fed into the control unit, where they are continuously displayed. The indicator unit displays the ground track angle, course to destination and distance to destination, and contains the greater portion of the computing elements.

System mechanics

An appreciation of the extent of the effort involved in providing system compatibility can be obtained by examining the functions of the computer. Since dead-reckoning navigation establishes the present position of the aircraft on the basis of a record of course and distance flown from a given fixed reference, ground track and ground speed must be determined. In the case of aircraft, the ground speed and track are the resultant of the air speed vector and the wind vector. The air speed vector gives the velocity and direction of the aircraft relative to the air. Since the aircraft is flying in the air medium that is moving relative to the ground, the air's motion relative to the ground must be added to the motion of the aircraft relative to the air. The sum of these two relative motions gives the motion of the aircraft with reference to the ground.

Once the ground speed vector has been determined, the position of the aircraft is established on the basis of computing the distance traveled along the ground track from the point of reference. When the present position has been fixed, with reference to the base point, it is possible for the pilot or navigator to obtain course and distance to the destination by direct measurement of these quantities from a chart. This is the procedure usually employed if the aircraft has no computer. Calculation of ground track distance is based, in this system, on the assumption that the aircraft is traveling in a succession of straight line segments. Each segment is the result of the aircraft traveling in a certain direction for a definite period of time. Unfortunately the finite nature of the distance and time considered does not permit consideration of transient changes in flight path due to variations in drift or combat and evasive maneuvers.

The function of the ASN-9 computer is to perform the above operations automatically and continuously. To do this the computer determines the components of ground speed along and normal to the course to destination vector. It then combines and integrates these vectors to determine the new course and distance to the destination. Of course, these operations are performed continuously from the time the aircraft leaves its base until it reaches its destination, no matter what the flight path followed.

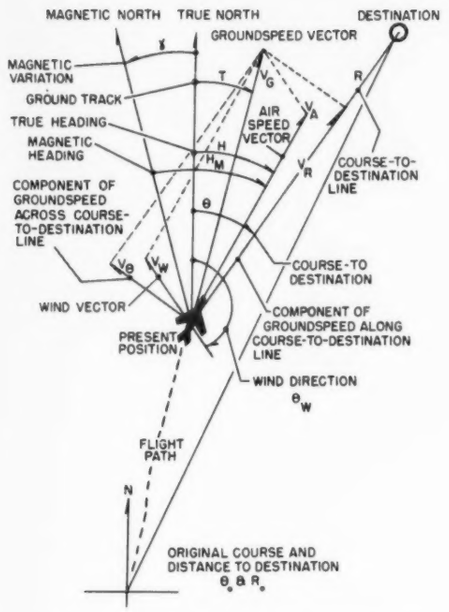


Fig. 3: Vector diagram of the flight parameters. The computer breaks down the true air speed into two components, parallel and normal to the course. To these are added the corresponding components of the wind speed vector, and the two totals are integrated to give the present course (Θ) and distance to destination.

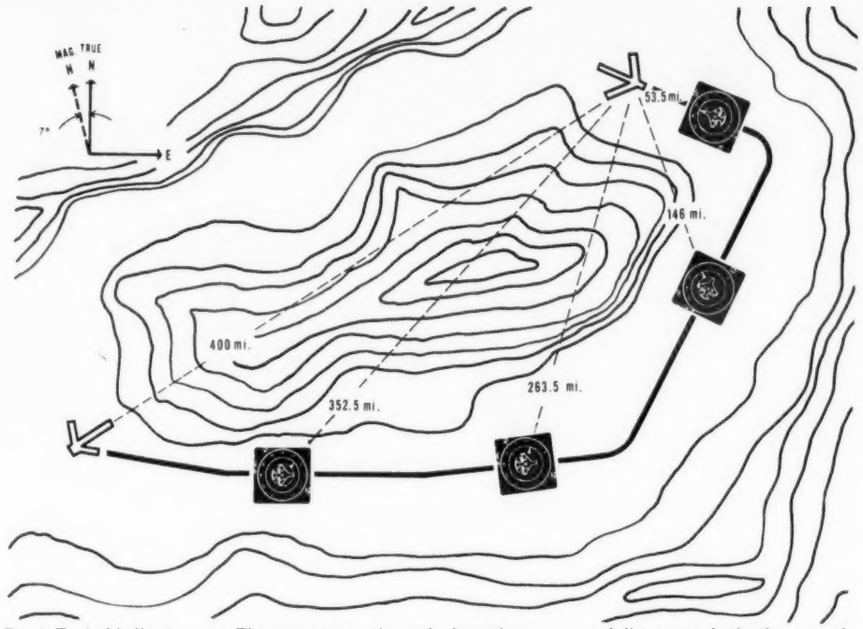


Fig. 4: Typical indirect course. The computer continuously determines course and distance to destination, regardless of track followed.

Figure 3 is a vector diagram of the flight parameters. From the time the aircraft leaves the reference point, the computer resolves the true air speed vector into the cross-course and along-course components. These are added to the cross-course and along-course components of the wind velocity vector. The sums of these components are integrated to produce the course and distance to destination in accordance with the equation:

$$\frac{dR}{dt} = V_R = V_A \cos(\Theta - H) + V_W \cos(\Theta - \Theta_W) = V_G \cos(\Theta - T)$$

$$\frac{d\Theta}{dt} = \frac{V_\Theta}{R} = \frac{V_A \sin(\Theta - H) + V_W \sin(\Theta - \Theta_W)}{R} = \frac{V_G \sin(\Theta - T)}{R}$$

In its basic configuration the computer is adaptable to aircraft with speeds in the range from 150 to 1,500 knots. Although the ASN-9 is a 2 percent computer this accuracy applies over the entire speed range. In service the computer is adjusted to a particular aircraft speed range with a resulting accuracy better than 1 percent.

A typical flight problem is shown in *figure 4*. The original destination range and heading are dialed into the indicator unit by the pilot. Wind velocity and heading are dialed into the control unit along with the mean magnetic variation between the flight terminals. At the instant the aircraft passes over the reference point on its outward course, the unit is activated. As shown in the representations of the indicator units along the flight path, the ASN-9 maintains a continuous display of course and distance to the destination.

Flexibility ... a performance factor

One aspect of equipment performance especially important in a navigation system is adaptability of the system to various types of input information and modes of operation. Such flexibility is advantageous not only because it permits the equipment to be used in a wide variety of aircraft but also because it represents insurance against obsolescence. As an aircraft undergoes modifications that may alter the nature of the airborne information available for navigational use, the ASN-9 may be easily modified to make use of the new information sources.

For example, the usual inputs to the ASN-9 are magnetic compass heading and true airspeed. However, the organization of the computer is such that incorporation into Doppler radar installations can be accomplished in several different modes of operation. *Figure 5* is a block diagram of the ASN-9 in a Doppler mode. In this installation, ground speed, provided by the Doppler equipment, is used instead of true air speed, and the sum of heading and drift angle is used instead of the heading alone. Drift information supplied by the Doppler supplants meteorological wind data required in the basic mode of operation and reduces system error to 1 percent.

In the event that Doppler information is lost due to poor signal-to-noise ratios or aircraft altitudes beyond the radar scan limits, this configuration of the ASN-9 reverts to the basic computing mode.

More complex adaptations of the ASN-9 make use of the improved accuracy resulting from Doppler information by continuously computing the latest wind information from the Doppler inputs. Memory circuits retain this data for use during the periods when Doppler operation is interrupted.

*

Extensive testing of the ASN-9 has borne out the thoroughness with which the systems approach anticipates design problems. Flight tests have been completed for the basic configurations, and military specifications have been met or exceeded. At present the unit is undergoing flight tests in various Doppler installations.

Providing all the vital position and steering information with almost negligible space and weight demands, the ASN-9 is operational testimony of the practicability of systems engineering.

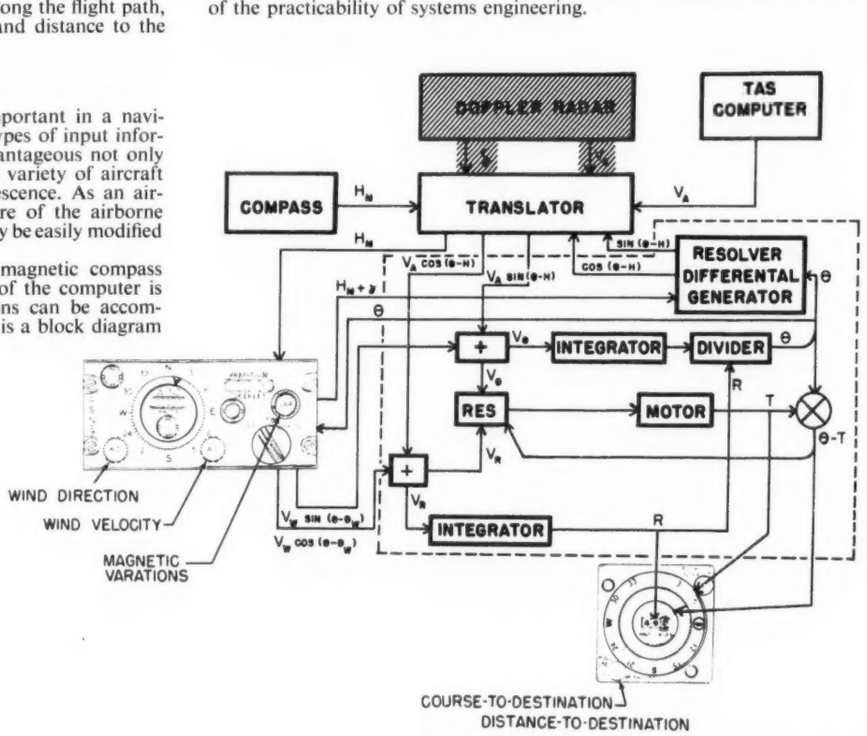


Fig. 5: With slight modifications the ASN-9 computer can be used in various ways with input data from Doppler radar systems. As the accurate drift angle provided by the Doppler radar eliminates the need for manual feed-in of meteorological wind data (generally inaccurate), the system's overall error is reduced to 1 percent. Loss of Doppler information is countered by reverting to the basic computing mode, when true air speed (from the TAS computer), heading (from the compass) and wind vector (wind direction and wind velocity) are employed to compute ground speed.

Blind Landings for Passenger Transports?

By Georges Charot, Ingénieur de la Navigation Aérienne, Telecommunications Division, Air Navigation Service, Paris

For several years the civil air transport companies have been concerned at the financial burdens imposed by the diversion in bad weather of aircraft to alternative airports, often in areas located many miles away from the scheduled flight destination point. The results of such diversions already have a significant effect on the carriers' economic operations: payload capacity cannot be fully exploited due to the additional fuel which must be carried to allow for this eventuality; and frequent diversions have a psychological effect on passenger sales through the inconveniences caused. These factors, which can well become aggravated with the introduction into service of the new jet transports, are incompatible with the forecast growth in the air transportation field, unless some method can be found of securing an appreciable reduction in the minimum landing requirements; that is to say, the minimum acceptable conditions of both visibility and cloud base.

To this end one of the basic objectives of both the carriers and the authorities responsible for airport operation is to provide the pilots of the future with the possibility of landing in conditions of zero visibility. Some years back the IATA companies posed the problem to a special study group (The Flight Technical Group) comprised of pilots, engineers and operations specialists set up to study the optimum utilization of existing ICAO navigational aids in an attempt to reduce the minimum landing requirements.

*

In this field many studies have been carried through, and it is of interest to consider here some of the factors affecting the problem.

At the present time the absolute minimum conditions for landing aircraft of the 40-ton gross weight category are 800 yards visibility and a cloud base at 200 feet. One of the most important basic reasons for the adoption of these limits is to be found in the method of piloting in which a critical factor is the "total reaction time", determined from:

a) The time required for the pilot to read the aircraft flight control instruments. This is in the order of 2 to 3 seconds depending on individual pilot ability, the degree of fatigue present, and the flight conditions of the moment;

b) the psychomatic reaction time, for the average pilot 1 to 2 seconds;

c) the aircraft reaction time, which in the case of contemporary four-engined aircraft in the 40-ton-plus category can be taken as approximately 2 to 3 seconds.

The "total reaction time" thus lies between 5 and 10 seconds, and this factor must be considered in relation to the aircraft oscillation period about the approach path. So long as the total reaction time is small in relation to the oscillation period, it is possible to successfully apply corrections. But if this is not the case, then the aircraft oscillations cannot be smoothed out, and the magnitude of these oscillations combined with the proximity of the ground present an acute danger; the critical break-off point is reached.

The greater the total reaction time then the greater is the distance of this critical point from the runway threshold. For four-engined aircraft of the types currently in service this can be reckoned, in instrument landings, as a point 800 yards from the threshold and at an altitude of 200 feet; this represents a flying time of approximately 20 seconds. Beyond this point in the approach flight it must be possible to carry through the landing manoeuvre under visual flight control.

Why is the final approach and landing only possible under visual flight conditions and not on instruments? Two main factors decide the answer to this question:

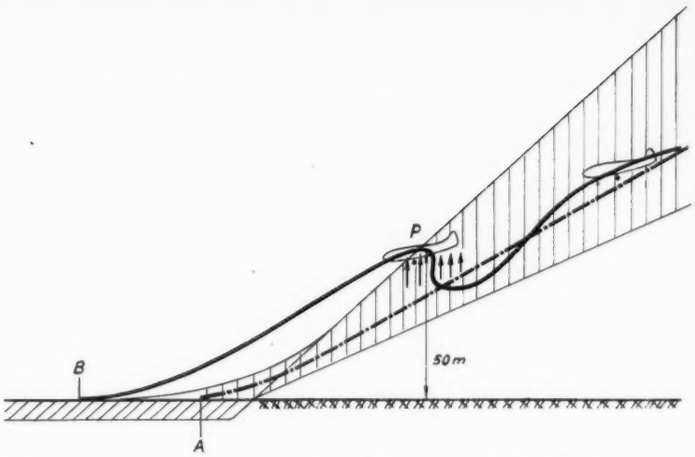


Fig. 1: One important means of reducing landing minima would be to give the pilot the choice of approach path to suit the given conditions. Any attempt to adhere rigidly, regardless of circumstances, to the ideal path marked out by the approach aids (ILS or GCA) puts the aircraft in danger of being driven out of the "glide space", for example by gusts (arrows). The ILS approach path represents only one of the possible routes; an alternative would be the line *PB*. Similarly the touchdown point can be selected within a relatively large area (hatched) and need not necessarily coincide with the ILS touchdown point (*A*).

1. In a visual landing the pilot is assisted in his manoeuvring of the aircraft by direct synoptic information in the final stages of his approach run. Pilot observation and reaction times are thus reduced to the minimum;

2. In a visual landing the aircraft is not rigidly dependent on an ILS approach beam, which is itself only one of the possible approach paths. In addition the pilot has a free choice of a comparatively large area of runway from which to select his final touchdown point.

*

The solution to the problem is therefore to be found in a more satisfactory method of presenting flight information to the pilot. This must permit:

a) A reduction in the total reaction time—by the utilization of an automatic pilot device whose reaction time is negligible in relation to that of the aircraft; or presentation to the pilot of synoptic flight information of a quality comparable to that available to him in a visual landing;

b) Choice of the most suitable of the available and possible approach paths.

Currently the difficulty of the problem lies in the fact that an aircraft attempting to line up on the ideal approach path (ILS; GCA) is threatened, for example by turbulence, by the possible risk of being forced out of the approach lane (cf. *fig. 1*)[1].

"Blind" landing systems which presuppose the use of a predetermined glide path at a mandatory altitude should, for these very reasons, be replaced by a more flexible system. Here there are two possible solutions:

1. The ILS signal fed to the automatic pilot could be replaced by the output data from a computer which processes information from altimeter, gyros, distance meters, etc., and selects the optimum approach path to meet the conditions of the moment;

[1] This statement does not imply criticism of radio approach aids (ILS; GCA, etc.).

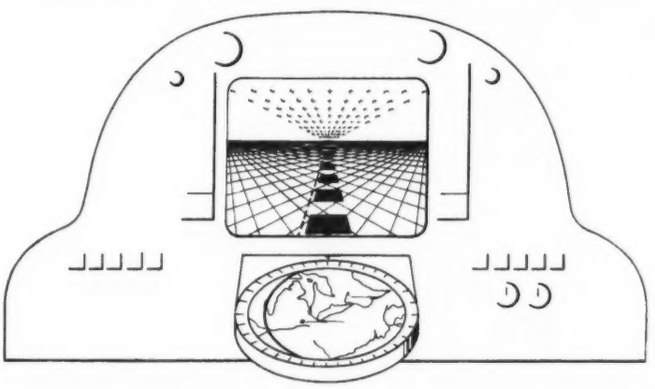


Fig. 2: The airborne equipment developed by the U.S. Navy presents flight information on a transparent television screen, in the form of a band which simulates the ground ahead, with allowance for the aircraft's attitude.

2. Presentation to the pilot of flight data which will give him the possibility to determine with ease and simplicity his precise position in the approach area, and to carry through his final approach and touchdown under the same conditions as are available to him in a visual landing.

The search for a solution using an automatic pilot in no way implies the rejection of the human element. On the one hand the automatic pilot must be constantly supervised, particularly in the case of an aborted approach; on the other hand, a landing under 100 percent automatic control of the aircraft raises such considerable psychological difficulties that the first step must be to find a solution utilizing human skills.

In these circumstances, the most urgent task appears to be to seek an improvement in the presentation of flight information. Experimental work on this problem indicates that a system for the cinematographic presentation of the data may answer the requirements.

In Britain several pilots, without any special training, have successfully carried out "under the hood" blind landings, utilizing only the TV picture presented by a camera mounted in the aircraft nose.

Interavia readers will already be familiar with the principles employed in the Link Aviation Incorporated DC-8 Simulator.[2] Mounted in front of the pilot cabin mock-up is a 11 × 15 ft. screen on which the student pilot sees an exact reproduction of the airport area as seen from his DC-8. This picture is produced by closed circuit TV, electronically coupled to the aircraft movements, so that the TV camera scans a miniaturized topographical reproduction of the airport area.

In addition, the U.S. Navy has developed an airborne equipment[3] which enables information to be presented on a transparent screen *(fig. 2);* this system employs a band picture reproducing the view of the area ahead of the aircraft conforming to the aircraft's attitudes and manoeuvres.

Finally, in June 1957, a Frenchman, Ingénieur de l'Air *Commandant Jacquet*, demonstrated a system which combines the picture acquisition and transmission principles of the Link G-67 Simulator with the advantages of the U.S. Navy's picture reproduction tube.

A ground-based TV camera scans a miniaturized reproduction of the airport runway and surrounding area. The camera is radio-electrically coupled to the aircraft in such a manner that a continuously relative perspective of the actual ground available to the aircraft is presented.

Despite its apparently greater complexity, this system is not without interest. In practice the cost of the airborne equipment would probably be lower than for the U.S. Navy's system, because the picture is not produced in the aircraft but only reproduced by a TV receiver. So far as the high-priced ground equipment is concerned it is only a question of equipping the airport and not the individual aircraft using the airport. If it is also found possible to simplify the airborne equipment for the system proposed by Jacquet, it may have preference over the U.S. Navy system. In any case a proposition of this type cannot be ignored.

[2] Cf. *Interavia* No. 11, 1958, p. 1189.

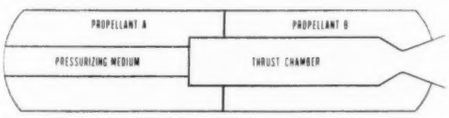
[3] Cf. *Interavia* No. 3, 1955, p. 184.

The 13th Annual Meeting of the American Rocket Society

More than 5,000 scientists and engineers from the U.S. guided missile industry, as well as observers from all over the world, took part in the 13th Annual Meeting of the American Rocket Society held from November 17th to 21st, 1958, at the Hotel Statler-Hilton, New York. This was probably the biggest rocket and space travel congress ever to be held, and was a great deal more than a social gathering: expertly and unobtrusively organized, the seventeen sessions—five of them secret—discussed all immediate problems connected with space travel and space weapons: the design and manufacture of sealed cabins for space ships, psychophysiological aspects of man living and working in space, nuclear propulsion, propellant problems, magnetohydrodynamics, the U.S. rocket research programme, etc. The five classified sessions, all of them organized by the Army Ballistic Missile Agency, discussed ramjets and mixed cycle engines, guidance problems large liquid rockets, large solid rockets, and the U.S. space capability.

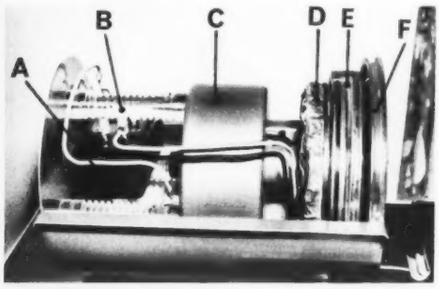
The social climax of the Meeting was the Honors Night Dinner on November 19th, at which the speaker was Lt. Gen. James M. Gavin (Ret.), today Vice President of Arthur D. Little, Inc. At this dinner, six engineers and scientists received awards, including Captain Iven C. Kincheloe, who was killed in an accident a few months ago. Finally, Col. John Paul Stapp, Chief of Aero Medical Laboratory, was elected President of the American Rocket Society for 1959. In 1954 Colonel Stapp rode a rocket-propelled

Shown for the first time in public: The LR44-RM2 *Guardian I* liquid-propellant rocket engine (right) and the *Guardian II* (in the background, left), developed by Reaction Motors Inc. The powerplants are supplied ready filled with propellants and require no checkout before operation.



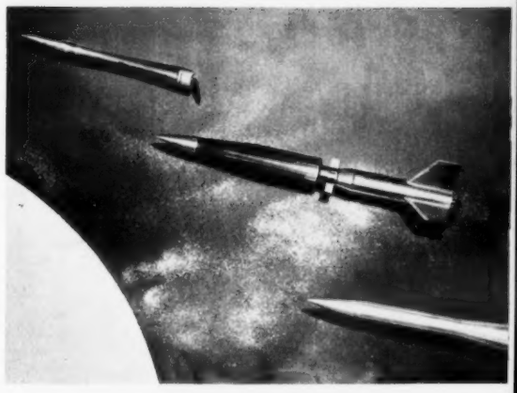
Reaction Motors Inc.'s Type 50-K liquid-propellant rocket powerplant with integral fuel tanks (see drawing above); thrust is 50,000 lb. for six seconds.

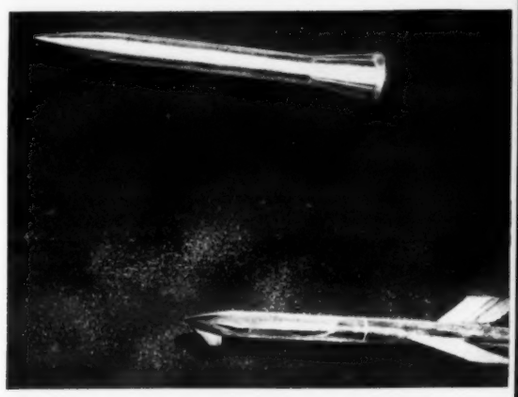
Full-scale cutaway model of the ion rocket engine (0.25 lb. thrust), which has been developed by the Rocketdyne Division of North American Aviation. It is now being bench tested on a special Rocketdyne test stand. Breakdown is as follows: A — control box; B — stand-off insulators; C — propellant tank and boiler; D — diffusion chamber with diffusion plates to obtain uniform distribution of propellant vapor; E — focusing electrodes; F — accelerating electrodes.



Model of a Boeing multi-part solid-propellant take-off booster, built up of separate inexpensive parts; it is to be used for research purposes in connection with the *Dyna Soar* project.

The Atlantic Research Corporation's *Arcas* 7-ft. high-altitude research rocket, which has been developed under an Office of Naval Research contract, is capable of transporting a 12-lb. instrumentation package to an altitude of more than 200,000 ft.





Grumman Aircraft Engineering Corporation exhibited a number of wind tunnel missiles, which have been under study during the past two years. *Upper picture*, top to bottom: wingless inherently stable test missile for hypersonic speeds; cruciform test missile with very low aspect ratio wings and cruciform tail surfaces. Solid-propellant booster was used. Wingless missile similar to that above. *Lower picture:* Wingless rocket model, broadening conically towards the rear; canard-type missile with adjustable nose vane for stability tests.

sled at 632 m.p.h. and braked to a halt in 1.4 seconds, imposing a maximum force of 40 g on his body. Volunteering for 26 of these rocket sled tests, he sustained numerous injuries, but succeeded in exploring human tolerance to crash type forces, thereby establishing human resistance limits.

*

The ARS Meeting was combined with an Astronautical Exposition, at which more than fifty manufacturers showed their products and a number of models of hitherto secret space vehicles and missiles.

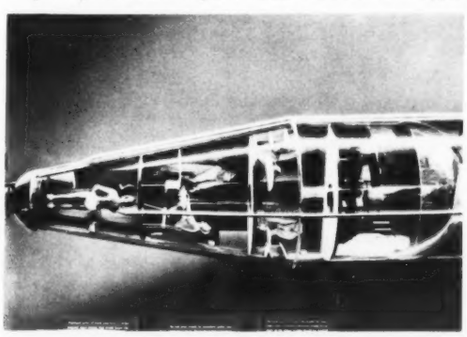
Reaction Motors Division of Thiokol Chemical Corporation, of Denville, N.J., introduced a new family of pre-packaged liquid-propellant rocket powerplants, designed for immediate operation. These included *Guardian I, Guardian II* and a 50,000-lb. thrust engine, designated Type 50-K. These cylindrical engines are supplied as complete, easily handled units, which are loaded with propellants at the factory and can be stored in the field for extended periods under extremes of environmental temperatures. Haveg Industries, of Wilmington, Delaware, announced a new material for missile insulation, known as *Orbiton*, which shows great promise in missile applications involving temperatures of 4,000 °F and above. Possible applications include motor liners, jet vanes, guide vanes, tail pipe insulation, etc. *Orbiton* consists of organic fibres such as Dacron or Orlon bound by thermosetting plastic resins.

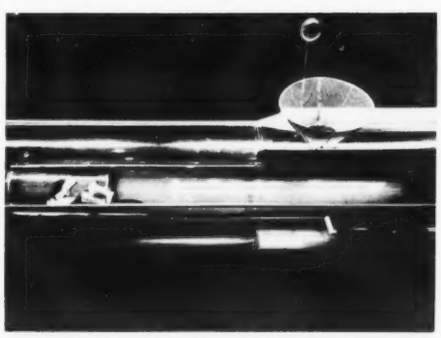
Development of a new "fuel cell" for electrical power was revealed by Dr. Morris Eisenberg, of Lockheed Missile Systems Division. In principle the fuel cell functions like a lead/acid automobile battery except that the undisclosed chemicals used can be stored outside the cell.

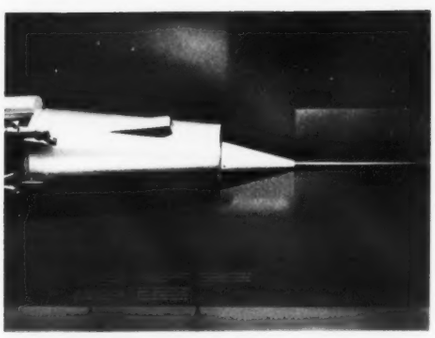
Dr. George P. Sutton, last year's President of the American Rocket Society and consultant to the Rocketdyne Division of North American Aviation, reported on the results achieved by Rocketdyne's Propulsion Field Laboratory on small ion rocket engines and on the equipment of the new laboratory. At a press briefing Dr. Sutton and Dr. Robert H. Boden (also of Rocketdyne) demonstrated a full-scale model of an ion rocket engine, which although it produces only 0.25 lb. thrust has sufficient power to propel a five-ton vehicle through space at a speed of several hundred thousand m.p.h. The propellants used are chemical substances, such as uranium tetrachloride, thorium, mercury or the alkali metals cesium and rubidium. The propellant is vaporized and broken down into positive ions and negative electrons, whereupon the ions are ejected by an electrical charge to provide thrust. The electrical power would be supplied by a small nuclear reactor. The first test ion rocket engine will be tested some time this month.

The accompanying pictures give a brief glimpse of the Astronautical Exposition. Admittedly, most of the exhibits were models, but these were pointers to future development.

The Convair Astronautics Man-in-Space Project: Using *Atlas* take-off boosters, Krafft Ehricke plans to construct a space station for four observers in about five years; it would be established in permanent orbit 400 miles above the earth. The three pictures below show, left to right: crew quarters and command post; non-pressurized centre portion with entrance, transport tunnel and air locks to the crew's quarters; rear portion with emergency rockets and atomic powerplant in case of power failure on board. The upper picture is a side view of the complete Convair model.







What's in the Air?

Extracts from Interavia Air Letter, *daily international news digest, in English, French and German. All rights reserved.*

AIR TRANSPORTATION

● **Aircraft Exchange Inc.,** a new organization to handle the purchase, sale and lease of transport aircraft, will begin world-wide operations from its offices in New York and London on January 6th, 1959. President of the Exchange is Robert I. Helliesen. The Board of Directors includes the following: Ch. N. Biondi, Vice President; Herbert B. Dorau, Treasurer; Alfred C. Turino, Secretary; Ralph V. Hudnut; Edward A. Merkle and Morton Wolovsky. Address is 522 Fifth Avenue, New York 36, N. Y. Similar to stock and commodity exchanges, the Aircraft Exchange will provide a record of bids and offers. It will issue its first weekly Market Report, covering quotations on all types of transport aircraft of 20,000 lb. and over, on January 8th. An affiliate corporation, known as Aircraft Exchange Services Corporation, will assist buyers and lessors of aircraft in Europe, Latin America and other areas outside North America in finding dollar financing for the aircraft they wish to purchase or rent.

● **The U. S. Civil Aeronautics Board** has tentatively approved an unprecedented airline industry plan to share profits when any carrier is prevented from operating by a strike; the plan involves Capital Airlines, American Airlines, Eastern Air Lines, Pan American World Airways, Trans World Airlines and United Air Lines. A CAB hearing on the proposal, which has been bitterly criticized by the trade unions, is to be held on January 14th. Simultaneously, the CAB outlined the issues to be considered at the hearing. These are whether the pact violated the Railway Labor Act, whether it improved or impaired labour-management relationships or discriminated between air carriers, and what effect it would have on Government subsidies. The role played by the Government in labour disputes will also be studied. Thus far, Capital Airlines has received two payments based on what the major airlines earned over and above their regular income when Capital's aircraft were not operating during the strike in October 1958.

● **An air agreement** between the German Federal Republic and Canada has been initialled in Ottawa; an exchange of notes on route patterns also took place. Under the agreement, Trans-Canada Air Lines will be authorized to operate air services between Canada and Düsseldorf and beyond to Vienna, as well as to another European city to be specified at a later date. Deutsche Lufthansa A.G. will have the right to operate air services between the Federal Republic and Montreal and beyond to Chicago. As soon as a second European terminal is specified by Trans-Canada Air Lines, Lufthansa will be authorized to operate to Boston or New York via Montreal. Lufthansa has been maintaining a service to Montreal and on to Chicago since 1956 under a provisional accord, whereas Trans-Canada Air Lines has been operating to Düsseldorf since 1952. The new agreement has to be approved by the two Governments and is subject to ratification.

● **American Airlines** will introduce the Boeing 707 on the first jet service across the United States, between New York and Los Angeles, on January 25th, with daily non-stop flights in each direction. A second daily non-stop flight in each direction will be added on February 1st. Two days earlier, on January 23rd, services with the *Electra* will be inaugurated between New York and Chicago, with six daily non-stop roundtrip flights. The 707 will operate between New York International Airport and Los Angeles International Airport, while the *Electra* will use New York's LaGuardia Airport and Midway Airport in Chicago. By mid-1959 Boeing 707s also will be serving San Francisco, Chicago, Washington D.C., Baltimore, Dallas and Boston.

● **British Overseas Airways Corporation** has relinquished 80 percent of its holding in Bahamas Airways (which was previously completely owned by the Corporation). The interest has been acquired by David Brown, head of the David Brown Corporation, and Eric Rylands, Managing Director of Skyways Ltd. This is the latest move in BOAC's attempt to reduce the losses on some of its subsidiaries which have been a big part of the annual deficit.

● **Alitalia's Rome—Turin—Paris Viscount service,** which is being flown three times a week throughout the winter, will become a daily service on the Turin—Paris lap on April 1st, 1959. The flight from Rome arrives in Turin in the evening. During the night, the aircraft is used for charter operations by a Turin company, returning to Turin-Caselle Airport in the morning and resuming its flight to Paris.

● **Aerovias Aquila,** a new independent Portuguese company, is to operate routes linking various parts of Portugal with the Azores. The company is acquiring three *Solent Mark 4* flying-boats from the British airline Aquila Airways, which suspended its Southampton—Lisbon—Funchal route at the end of September, 1958.

● **The Government of North Rhine Westphalia** has decided to develop Cologne-Wahn rather than Düsseldorf as the Federal Republic's second intercontinental jet airport. Cologne-Wahn Airport is to be enlarged at a cost of DM 46,000,000 and re-named *Rhine-Ruhr Airport*. The development project submitted to the Land Government calls for an expenditure of DM 19,400,000 for a new 12,470-ft. runway. Erection of a new terminal will cost DM 10,000,000 and construction of approach roads and a railway line are estimated at DM 13,700,000 (including acquisition of land).

● **General Georges Fayet,** Managing Director of Transports Aériens Intercontinentaux, has been elected President of the Fédération Internationale des Trans-

Professor Vittorio Valletta, President and Managing Director of Fiat (centre of picture), and Professor Giuseppe Gabrielli, Manager of Fiat's Aviation Division (on Prof. Valletta's right) were recently awarded a gold medal by the Unione Giornalisti Aeronautici Italiani (UGAI) for their part in the development and construction of the Fiat G.91

New Mark 2a version of the Australian Government Aircraft Factories' unmanned Jindivik *target drone. Like its predecessors, the Mark 2a is powered with an Armstrong Siddeley* Viper ASV. 3 *jet engine; Mark 2b (powered by ASV. 8) and Mark 3 (with ASV. 11) versions are under development.*

Société Générale des Transports Départementaux (Les Courriers Normands and Compagnie Normande d'Autobus) operated an experimental helicopter service last summer between Caen and Le Havre, with four intermediate landings at Ouistreham, Cabourg, Deauville and Honfleur. The Vertol 44 for 15 to 17 passengers was used; before take-off from Caen helicopter airport (La Prairie).

The first Douglas DC-8 to be fitted with four Pratt & Whitney JT4A (J75) jet engines has now commenced flight testing.

The new Piper PA-25 Pawnee *agricultural aircraft, fitted with a 150 h.p. Lycoming engine, limited production of which is due to begin this year.*

Cessna Aircraft Co.'s new "C" Version of its well-known Cessna 310 four-to-five-seat executive aircraft is being put on the market this year. The 310C is fitted with two 260 h.p. Continental 10-470-D engines. As compared with last year's version, the aircraft has improved performance; price $59,950.

This year Piper is also offering this attractive Piper Caribbean *four-seater for $8,395. One 150 h.p. Lycoming engine. The manufacturers hope for successful sales of the aircraft, particularly to aero clubs.*

porteurs Aériens Privés (International Federation of Independent Air Carriers) for 1959. He succeeds G. H. Freeman and is the first Frenchman to be elected President of FITAP. Some 50 independent airlines are members of the Federation.

● **Pan American World Airways** has announced the election of John C. Pirie as a Vice President. Formerly the company's Associate General Counsel, Pirie will retain that position with the title of Vice President and Associate General Counsel.

INDUSTRIAL

● **Avro Aircraft Limited,** Malton, Ontario, has ended its CF-100 programme with the completion of the 692nd CF-100; the value of the programme is approximately $450,000,000. The CF-100 is of particular significance to the Canadian aviation industry as it was the first aircraft to be entirely designed and produced in Canada for North American defence. Tied in with the CF-100 programme are its powerplants, the Canadian designed and produced *Orenda* jet engines. The last of these was completed recently when the 3,794th came off the assembly line to finish a programme worth $440,000,000. The last CF-100 is the Mark V and the ninth variant of the aircraft. The programme began in 1947 when detailed design on both CF-100 and *Orenda* was started. *Orenda*-powered CF-100s constitute the nine Royal Canadian Air Force squadrons which are a vital part of NORAD. They are also used by the Belgian Air Force. *Orenda* engines are used by West Germany, South Africa and Colombia in *Sabre* aircraft.

● **A Royal Commission** enquiry into the relative merits of the CF-105 *Arrow* manned interceptor and the *Bomarc* anti-aircraft missile has been proposed by a joint committee of the United Auto Workers and the International Association of Machinists, representing 35,000 Canadian aircraft workers. Canada has been considering the purchase of the *Bomarc* from the United States, and in this case would drop the *Arrow* project. A final decision is not expected before the end of March 1959.

● **Jan Zurakowski,** at the age of 44 and after 24 years of flying, is retiring as a test pilot. Zurakowski came to Avro Aircraft Limited at Malton to test the CF-100 and was the first to test fly the Avro CF-105 *Arrow*. In 1951, in Farnborough, he invented the first brand new aerial manoeuvre in 20 years, now called the Zurakowski cartwheel.

● **Edgar Percival Ltd.,** which was earlier this year involved in winding up proceedings, has been purchased by Samlesbury Engineering Ltd., one of the Eric Rylands Ltd. Group of Companies. One of the main activities will be the continued production of the EP.9 single-engined general purpose aircraft. The name of the company will be altered from Edgar Percival Ltd. to Lancashire Aircraft Corporation Limited.

● **Compagnie des Ateliers et Forges de la Loire** (CAFL) has been licenced by Union Carbide Corporation to manufacture in France refractory and stainless alloys based on cobalt, chromium, nickel, molybdenum, etc., and to use the trade names of Hastelloy Alloys, Multimet and Haynes. Production under Union Carbide specifications will take place at CAFL's Unieux and Firminy plants. Sales in France will be handled by Société Métaux Inoxydables Ouvrés, which has been acting as distributor for Haynes alloys imported from the United States. CAFL is authorized to export these alloys to all European countries through Union Carbide Europe S.A., of Geneva.

● **The Turboméca Bastan** has completed 150-hour bench tests and become the first French-designed turboprop engine to be certificated to ICAO standards.

● **Sud-Aviation's Super Alouette 3200** helicopter, designed to carry 28 passengers, will be exhibited at next year's Paris Air Show. Different versions of the *Super Alouette* will be offered (for civilian operators, Army, Navy and Air Force).

Development work is still going on at Milan-Malpensa Airport; the east wing of the new terminal building with visitors' terrace seen at the end of November 1958. The east runway is to be lengthened from 6,560 ft. to approx. 12,840 ft. The west runway is 8,610 ft. long.

Parade of the Lockheed Electra *in the grounds of the California Division plant, Burbank. Eight aircraft are destined for Eastern Air Lines, and two for American Airlines.*

The first Vanguard *turboprop airliner rolled out of Vickers' Weybridge plant on December 4th, 1958. Since then bench runs have been in progress and by the time these lines appear the* Vanguard *will probably be undergoing flight tests.*

Northrop Aircraft Inc. has announced the first production contract from the U.S. Air Force for the T-38A supersonic trainer. Value of the contract is $17,000,000. Picture shows part of the final assembly shop.

● **S.A. des Ateliers d'Aviation Louis Breguet** and Aircraft Maintenance and Engineering Company have reached an agreement to undertake jointly the overhaul of U.S. military aircraft stationed in Europe. Until recently this work was carried out by the USAF.

● **Rhein-Flugzeugbau GmbH.**, of Krefeld-Uerdingen, has been awarded a contract by the Argentine Government for one RW-3 multi-purpose aircraft. Another export order for this two-seat aircraft has been received from a private company in Mexico and a further RW-3 was recently delivered to Denmark. Contract negociations are in progress with a number of other potential customers both in Germany and abroad.

● **Wolf Hirth GmbH.**, of Nabern-Teck, is working on the development of a twin-engine four-seat sports and touring aircraft, the *Wanderfalke*, according to press reports. Powerplant: two 60/65 h.p. Porsche engines.

● **Lockheed Aircraft Corporation** has announced a $36,000,000 programme to equip about 350 U.S. Navy P2V-5 and P2V-7 *Neptune* patrol bombers with a "new concept" submarine detection system. Initial contracts valued at more than $18,000,000 cover production, assembly, and installation of the new electronic system. Prototype versions of the equipment are at the present time being tested on the *Neptune*. Delivery of the first aircraft to operating squadrons was scheduled for December, 1958.

● **Lockheed Aircraft Service-Overseas,** of Ontario, Calif., has been awarded a contract by Garuda Indonesian Airways to provide technical assistance for the operation and maintenance of Garuda's aircraft. The agreement makes available qualified maintenance and operating crews for the three Lockheed *Electra* turboprop airliners which Garuda has on order.

● **The Federal Division** of International Telephone & Telegraph Corporation in Clifton, New Jersey, has been chosen by North American Aviation, Inc., to develop and produce a multi-million dollar mission and traffic control system for the U.S. Air Force's F-108 interceptor. The initial contract to ITT is believed to amount to about $60,000,000; a part of this sum is expected to be diverted to other companies which will work with ITT on the project. The mission and traffic control subsystem will be implemented by Theodore M. Douglas, Federal Division Vice President, who will head the subsystem management organization.

● *The Fokker F.27 Friendship prototype No. 1* has been equipped with two Rolls-Royce *Dart RDa.7 Mark 528* power units of 1,910 s.h.p. each. It has also been announced that prototype No. 3 is to be fitted with weather radar equipment.

MILITARY AFFAIRS

● **President Eisenhower** has settled the jurisdictional dispute between the Army and the National Aeronautics and Space Administration over the United States space programme. The President ruled that the Army should retain control over its ballistic missile agency at Huntsville, Alabama, which employs some 2,000 scientists. On the other hand, the Army was ordered to relinquish control over its Jet Propulsion Laboratory in Los Angeles, California, which will be taken over by NASA. The latter had sought also to take over the facilities of Redstone Arsenal, but ran into vigorous opposition from the Army. The Army team in Alabama includes more than 100 German experts who came to the United States after World War II. The Army had opposed any change, claiming that if these scientists were transferred, their morale would be affected and missile development interfered with. Some observers said that although the President's decision appeared at first glance to be a victory for the Army, the Army's role in the overall space programme might now diminish to a point where there would not be enough work to occupy the scientists employed at the ballistic missile agency and they would presumably begin drifting into the NASA. The Jet Propulsion Laboratory, headed by Dr. William Pickering, employs about 2,300 scientists.

● **The Japanese Army** (Ground Self-Defence Force) has signed a contract with Vertol Aircraft Corporation, of Morton, Pennsylvania, for the procurement of an initial quantity of Vertol 44 transport helicopters. The Vertol 44 is currently in operation with the U.S. Army units in the U.S. and Far East, with the U.S. Air Force in Europe, the German Army, the Swedish Navy, and the French Army.

An Investigation of Mid-Air Collisions

The following study on aircraft mid-air collisions involving airliners has been published by the Institut du Transport Aérien (ITA), an international non-profit-making association, with headquarters in Paris. The association operates as advisory centre for economic and technical problems for the benefit of its members (international organizations, civil aviation authorities, airlines, aircraft manufacturers, airport authorities, fuel suppliers, universities, etc.) from 35 countries.

The collisions between an airliner and a military aircraft near Las Vegas and near Washington on April 21st and May 20th, 1958 respectively, brought the problem of safety in the air into the news. They were then discussed at length in the American press. The recent collision between a British *Viscount* and an Italian military aircraft in the vicinity of Naples has brought the matter into the headlines again. The Institut du Transport Aérien here sums up the practical conclusions of its recent comprehensive study of the question.

ITA based its study mainly on the actual accident investigation reports published by the competent authorities of the countries over whose territory the accidents occurred. These reports show that between 1945 and 1958:

—No French or British airliner was involved in a collision with another aircraft.

—One Canadian airliner collided with a military aircraft without incurring serious damage.

—Nineteen U.S. airliners were involved in mid-air collisions during the same period, seven of them with loss of life.

There are many more collisions over the United States because there are many more flights per day by airliners, military and private aircraft. Nevertheless, the Civil Aeronautics Administration's air traffic control methods have proved extremely effective and are likely to meet satisfactorily the new problems raised by increased traffic. This is the general conclusion to which the study leads.

Analysis of the twenty mid-air collisions over the United States and Canada since 1945.

	At take-off or landing	Cruising	With loss of life [1]
1. Airliner and private aircraft .	7	0	0
2. Airliner and military aircraft . .	3	6	5
3. Two airliners	1	3	2

[1] As the prime object of this ITA report is to study the safety of airliners, this table shows as accidents with loss of life only those in which there was loss of life to passengers or crew of airliners.

1. *Airliner and private aircraft*

All seven of these collisions occurred during take-off or landing, in the vicinity of airports used by both types of aircraft. CAA pilots reconstructed six times running an accident involving a twin-engine DC-3 and a small Cessna which collided on July 12th, 1955 in very good weather, near Fairfax airport, Kansas City.

The DC-3 took off when the Cessna was flying level towards the airport at 1,200 ft. Immediately after take-off, the DC-3 did a climbing left turn through 150°, at the end of which it collided with the Cessna. The CAA pilots and observers participating in the reconstruction declared that, though the sunshine created no glare, they had much difficulty in sighting the other aircraft even after several repeats. The Cessna pilot also stated, after watching the DC-3 do its climbing turn, that at no time did it appear to be on a collision course with his own. This is a very good example, because it shows how difficult it is for the pilot of an aircraft to see another aircraft even in good weather, as long as it is not in the immediate vicinity. And these were slow moving aircraft. The more rapid the aircraft, the greater the difficulty. This shows how frail a safeguard is the " see and be seen " principle.

This accident gives a good example of the optical illusions which may distort a pilot's judgment. For the pilot who sees another aircraft approaching cannot tell whether it is flying straight or making a turn which will bring it into a collision course with his own. As appears from this and the following, *only the technical methods and procedures of air traffic control services can remove risks of collision, just as the railway signal system prevents train collisions.*

There is a second conclusion to be drawn from the above statistics: *only private aircraft equipped for instrument flying and piloted by professionals well trained in controlled flying, should be allowed to operate from public transport airports.*

All seven collisions in the above table involved amateur pilots without that training.

2. *Airliner and military aircraft*

The U.S. Air Force has a number of reserved zones over the United States for pilot training. They are at over 20,000 ft., that is above the routes used by piston-engine airliners. But on their way to and from these zones. military aircraft pass near the civil air routes and, as they are not subject to the CAA air traffic control services, there is nothing to prevent them from colliding with a passing airliner. This is what happened in the six collisions involving airliners at cruising altitude. It was to improve the situation that the Federal Aviation Agency was created, with functions including that of organizing and effecting traffic control of all aircraft in the U.S. airspace.

Meanwhile, an emergency measure has been taken with the establishment of a 40-mile wide transcontinental corridor between 20,000 and 35,000 ft. in which all airways between the two areas are to pass. Military aircraft are not allowed in this corridor at any point or at any time.

Of the three collisions between airliners and military aircraft during take-off or landing, the first, with loss of 55 lives, was caused by a foreign military pilot, unpractised in American control procedures near airports. The second occurred in bad weather near a small airport where there was no traffic control. The third was due to an error on the part of a tower controller whom four aircraft, approaching from different directions, asked for landing clearance within a few minutes of each other. The last two accidents caused the loss of only one life — the pilot of one of the military aircraft.

3. *Between airliners*

Three of these were at cruising altitude and only one (the Grand Canyon collision) caused loss of life (128 victims). The accident investigation reports show that they could have been avoided if the three traffic controllers had shown a little more initiative. Without entering into detail, there is one central point worthy of note in connection with each of these accidents:

The Grand Canyon collision was between two aircraft travelling at an altitude of 21,000 ft. on routes converging at about 30°, the point of convergence being on a line of beacons known as Painted Line. Both aircraft reported their positions to the Salt Lake City controller. The official investigation report describes this controller's position as follows: " At approximately 10:13 the Salt Lake controller was in possession of the last position report made by each of the subject flights. He was then aware that when the reports were made both aircraft were operating at 21,000 ft., were on converging courses and were estimating the Painted Line at the same time. He advised neither of this situation. "

As the collision took place at about 10 : 51 over Painted Line, it is obvious that, if the controller had informed the two pilots of the risks they were running, the accident would have been avoided since they would have altered their plans.

Questioned on the subject during the hearing, the controller testified that " he was not required to give advisory information to flights which were in uncontrolled airspace, and it was only a discretionary duty in the controlled area. "

The CAA Director of Air Traffic Control explained as follows the reasons for this regulation: " Provision of an advisory service for traffic in uncontrolled areas would be tantamount to positive control of all traffic which would require personnel, facilities and equipment not presently available. "

Now American aeronautical authorities have decided, in principle, to control all heavy traffic routes over the country even in good weather. This is already being done for the routes between New York and California, as indicated above. But for other heavy traffic routes it will be possible only after the installation of the necessary control and navigation aids and the recruitment and training of many more personnel.

The two other collisions between airliners were also attributable to lack of initiative on the part of the controller. In both cases, two aircraft were cleared just after sunset; both had flight plans indicating that they were to use the same airway at the same altitude. In the first case, the slower aircraft (DC-3) took off first and the faster one (a DC-4) followed a few minutes later, the risk was great and a collision did in fact take place. The pilot of the DC-4 was informed that there was a DC-3 ahead but he saw its navigation lights too late. In the other case, the collision was between a Convair 240 and a Convair 340 when the pilot of the second aircraft to take off adopted a faster cruising speed than the first. There were no casualties in either of these accidents.

There was a fourth accident in bad visibility with a ceiling of 900 ft. between an airliner which had just taken off and another unreported airliner flying in the opposite direction. The latter had filed no flight plan and made no position reports. It was flying through cloud at the time. Fifteen persons were fatally injured in this accident.

Conclusions

First, two comments:

a) In thirteen years there have been only four collisions between airliners over the United States and Canada, and only two of them with loss of life.

b) Three of these accidents would not have happened if the air traffic controller concerned had shown a little more initiative and understanding of his function. The entire responsibility for the fourth rests with one of the pilots.

This shows that the CAA's air traffic control system and procedures have proved remarkably effective, since the four collisions there have been between airliners in thirteen years were entirely due to human shortcomings and not to the system's faults or failure to operate. This is a particularly meritorious achievement in view of the very high density of traffic handled at peak periods in, for example, the New York, Washington and Chicago area.

So far the main threat to airliners has been the passage of military aircraft which, in certains regions, were not controlled by the CAA's traffic services. The recent creation of the Federal Aviation Agency will soon remedy that state of affairs.

Collisions with private aircraft caused no casualties in the airliners concerned.

Consequences of the introduction of jet aircraft: Problems of navigation and traffic control are about to become more pressing as a result of the introduction of the jets and will call for new measures now being planned. It is reassuring to make clear from the start that, to a certain extent, these aircraft will reduce the danger of collision since they will fly above piston-engine aircraft, at over 20,000 ft. It is only in the approach zones of major airports that the risks will increase. The most effective instrument for their prevention will be surveillance radar which can show on the screen all aircraft within 100 to 125 miles. On it, the controller can follow the movement of all the aircraft in his charge so that he can forestall the risks of collision in time, provided that he has electronic computers to calculate automatically the future paths of the aircraft and warn him when two of them are likely to end in a collision. Such radar already exists on major American airports, and an electronic computer has since been developed and tested satisfactorily in the CAA Centre at Indianapolis.

At the same time a number of airlines are trying out Doppler navigation aids on their aircraft. These aids keep the pilot constantly informed of his own position and speed, without recourse to ground installations, and enable him to keep ground control up to date on them. The navigational accuracy and so the safety of all aircraft in the air are expected to benefit considerably thereby.

There is also an increasing tendency towards the control of all aircraft flying at over 10,000 ft. even in good weather.

The success with which the Civil Aeronautics Administration is now controlling six times as many aircraft as it handled just after the war is an earnest of success in its future operations as foreshadowed above.

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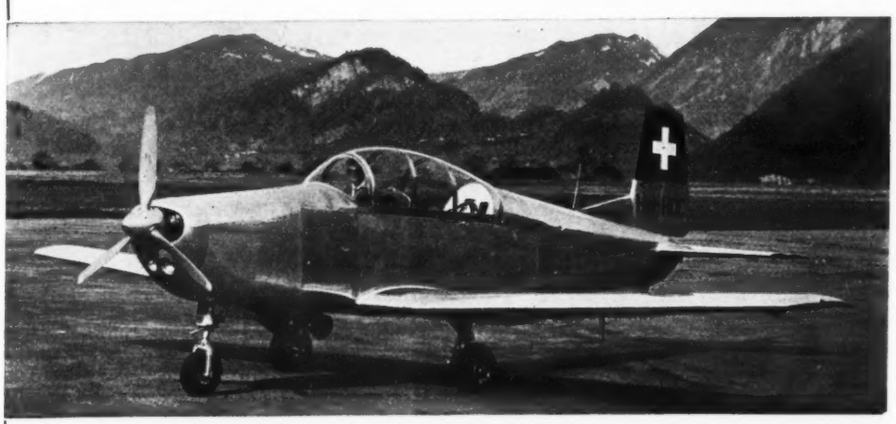

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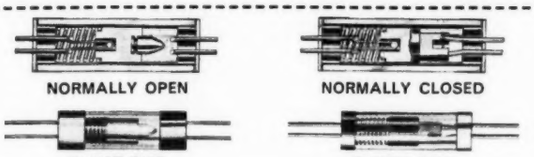

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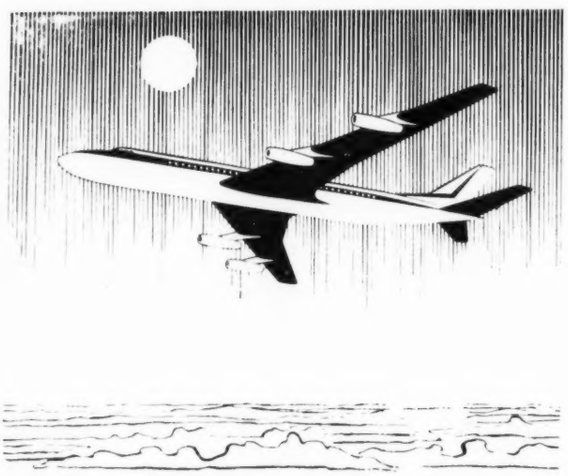

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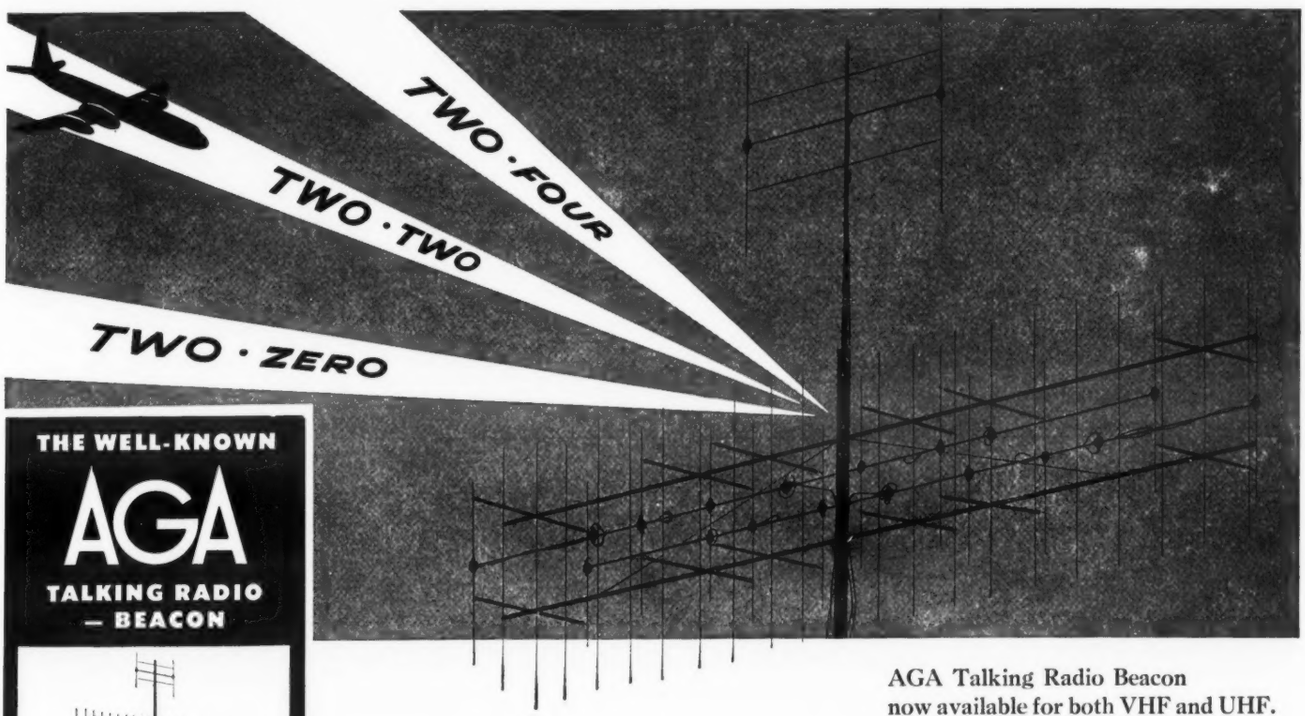

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List of Advertisers January 1959

	Page
Aerfer, Pomigliano d'Arco	96
Aero Design & Engineering Co., Oklahoma City	17
AGA, Svenska AB., Gasaccumulator, Stockholm	99
Aircraft Exchange, New York	32
Air France, Paris	29
Alitalia, Rome	99
Allison Engine Division, Indianapolis	31
Alvis Limited, Coventry	3
Armstrong Siddeley Motors Ltd., Coventry	13
Armstrong Whitworth Aircraft Co., Baginton	23
Atlas Copco A.B., Stockholm	62
Avro Aircraft Ltd., Malton	50
Bendix International, New York	82, 83
Blackburn & General Aircraft Ltd., Brough, East Yorkshire	84
Boeing Airplane Co. Ltd., Seattle	24
Bristol Aeroplane Co. Ltd., Bristol	60, 61
Canadair Limited, Montreal	86
Canadian Applied Research Ltd., Toronto	98
Canadian Marconi Co., Montreal	28
Cointrin Airport, Geneva	80
Collins Radio Corp., Cedar Rapids	47
Contraves Italiana S.p.A., Rome	48
Convair, San Diego	104
Costruzioni Aeronautiche Giovanni Agusta, Cascina Costa (Gallarate)	98
Decca Navigator Co., Ltd. London	59
Electric Auto-Lite Co., New York	30
English Electric Aircraft, London	38
Esso Export Corp., New York	102
Fairey Aviation Co., Hayes	36
Fiat S.p.A., Turin	8
Folland Aircraft Co., Hamble	10
Garrett Corporation, Los Angeles	19
Gilfillan Bros., Los Angeles	27
Goodyear Co., Akron	9
De Havilland Aircraft of Canada Ltd., Toronto	49
De Havilland Engine Co., Leavesden	20
Iberia, Madrid	100
International Standard Electric Corp., New York	7
Laboratoire Roger Bellon, Neuilly-sur-Seine	100
Lockheed Aircraft Corp., Burbank	37
Aeronautica Macchi S.p.A., Varese	101
Marconi's Wireless Telegraph Co., Chelmsford	16
Milan Fair, Milan	5
Minnesota Mining & Mfg. Co., St. Paul, Minnesota	6
Mobil Oil Overseas Inc., New York	26
D. Napier & Son Ltd., London	85
Networks Electronics Corp., Van Nuys	98
Nord-Aviation, Châtillon s/Bagneux	34
Normalair Limited, Yeovil	97
Northrop Aircraft Co., Hawthorne	15
Omnipol S.A., Prague	81
Philips Telecommunicatie Industrie N.V., Hilversum	14
Pilatus Flugzeugwerke AG., Stans	97
Plessey Co. Ltd., Ilford	35
Henry Potez, Paris	100
Clichés Richter S.A., Geneva	100
S.A.I.A.G., Cirié (Turin)	100
Clichés Schwitter S.A., Basle	102
SFENA, Neuilly-sur-Seine	101
SNECMA, Paris	18
Standard Financial, New York	98
Sud-Aviation, Paris	33
Swissair, Zurich	4
Technocommerz G.m.b.H., Berlin	103
Thomson-Houston, Paris	79
Triplex, Longjumeau	101
United Aircraft Export Corp., East Hartford	25
Whitehead-Moto Fides, Leghorn	100

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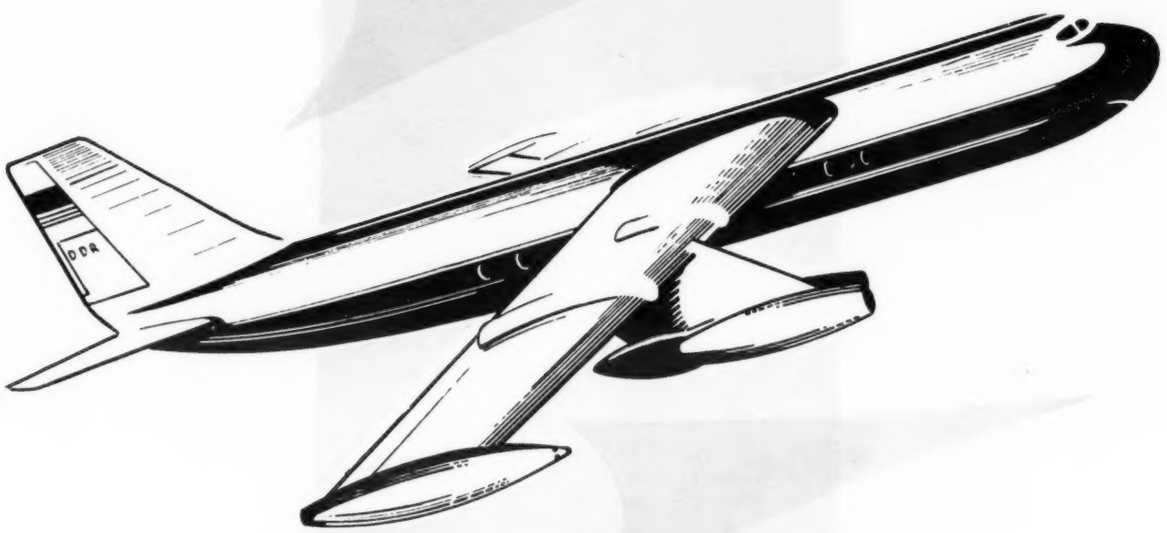

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